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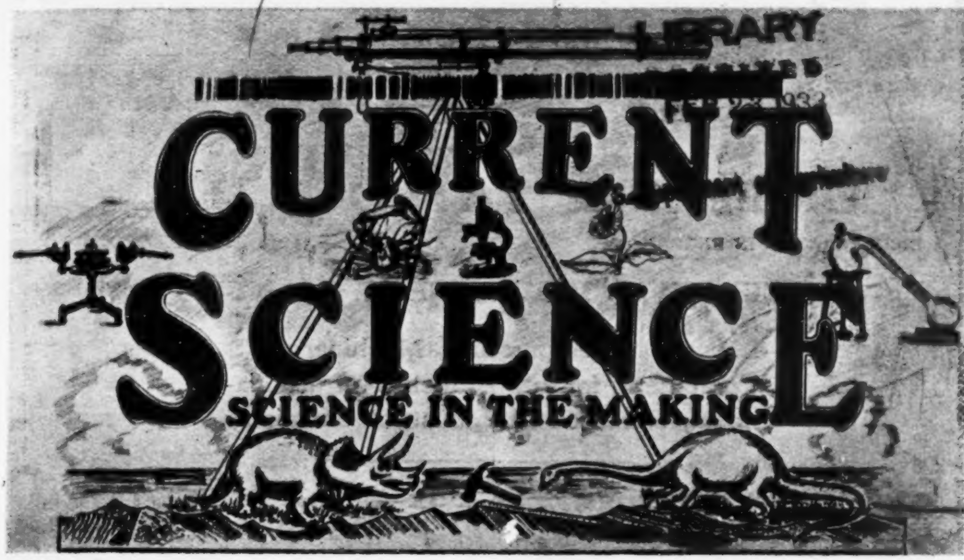

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Co-operation in Scientific Research.

ONE of the principal features of the recent development of higher education in India is the provision of facilities for scientific research in all the universities, and it is gratifying that the total annual output of work from their laboratories is increasing in volume and improving in quality. We have, at present, one university for every twenty millions of people and for every hundred thousand square miles. Judging merely from the geographical area of India and the density of her population, few will maintain that our eighteen or nineteen universities are excessive. We are rather disposed to think that in South India alone there is room for at least three more universities. It has now become part of the political doctrine of enlightened Indian public opinion that a wider diffusion of higher university education is indispensable to national progress.

Some well-meaning critics still hold that these centres of research and learning are directly responsible for the growth of unemployment in the cities, and propose that the funds now granted to universities should be diverted to the more useful and urgent purpose of spreading elementary and secondary education among the people. The disparagement of higher education by these popular representatives is probably due also to a vague apprehension that the money spent on the university benefits only a few, these few do not contribute directly to the earning power of the nation and the man who pays for them receives hardly any return for his money. We are afraid that this mode of reasoning can only be considered as a sample of the logic of democratic enthusiasm.

Furthermore, there is a class of reformers of Indian universities who advocate their conversion into technological and commercial institutions where young men undergoing practical training will be put in a position to earn their living and to contribute to the material prosperity of the society to which they belong. It is true that if universities are established in manufacturing centres, their technological sides will help to foster the local industries and may even help to maintain their supremacy; but it scarcely occurs to these zealous reformers that all universities are incapable of such transformation without prejudice to their more legitimate function. If a young man is destined for an industrial or business

career, it is in the workshop and the office of industrial institutions that he will learn his lessons more profitably than in the class rooms of the university. The village smithy, the local carpenter's table and the cottage handlooms provide really a more profitable training to the future rural industrialist than can be imparted in any secondary school. The fact is that all these adverse criticisms of the existing institutions are a product of an inverted snobbery.

Till recently the history of our universities has been one of routine and examinations and the colleges coming under their influence were naturally pre-occupied with fostering a kind of education devised to satisfy the rather arbitrary demands of public examinations, almost to the neglect of the equally important part of their function of promoting independent enquiry and freedom of thought. Where a system of external examinations is permitted to dominate the education of an affiliated institution, the latter tends to become mechanised and the products of such education will also tend to conform to an inelastic type, scarcely possessing a well-differentiated individual intellectual trait. In the universities in which there is abundance of good education and less examination, the result has always been a beneficial stimulation of post-graduate work in the laboratories and diminished numbers of bookworms, intellectual idlers and irresponsible critics in the country.

None of the numerous witnesses who deposed their evidence before the Sadler Committee has praised the system of university education, or upheld the unscientific method of examination then in existence; and almost every one attributes to these two causes the lack of an adequate output of work from research laboratories. It seems to us that a radical reform of the syllabuses of study for the various degree courses and a more humane scheme of examinations are urgently called for and that this desirable end can be secured only through the increasing exertions of the Inter-University Board. The general experience of the professors is that the intellectual curiosity of some of the brilliant young men, if it escapes the freezing influence of examinations, is in danger of being stifled by their poverty and naturally they proceed to seek employment under government rather than stay in the university to take up a piece of original work. For the purpose of increasing the output of original investigation from Indian universities, we would repeat and emphasize the well-known suggestions about a generous and stable financial scheme of research fellowships and post-graduate studentships which not merely attract and retain some of the ablest research workers in the universities but also provide for periodical encouragement by way of increments to their emoluments, the establishment of a number of endowed research chairs, financial provision for scientific expeditions other than official and the release of professors from routine which in the existing conditions gives them little time and less inclination for laboratory work. The public mind of India is steadily recognizing the value of scientific work and it is hoped that before long the wealthy section of the community will come forward with munificent donations for the creation of a network of research centres all over the country.

In the meantime the scientific investigations now being conducted in the different universities, in aided research centres, official scientific departments and laboratories maintained by private industrial organizations, can be strengthened and the rate of their progress accelerated through a definite scheme of co-operation and an agreed plan of work. At present the Indian Science Congress follows rather too closely the practice of the British Association for the Advancement of Science, in providing a forum for the reading of papers at the sectional meetings, in organizing public lectures on scientific subjects and joint meetings of sections for discussion of topics of common interest. There is, however, no provision in the Congress organization for directly promoting the advancement of science in India and its relation with the universities is not even formal. Its influence, therefore, on the general progress of scientific investigations is indirect and in the nature of things, quite remote. Separated by great distances, the workers in different centres of research might select and investigate almost identical problems and discover after the completion of their research that they have been anticipated, one by the other.

This avoidable and unnecessary duplication of work can be prevented if the delegates attending the Congress would meet and discuss the facilities afforded by their research laboratories for special work in the different branches of pure or applied science and the problems in which their colleagues,

their research scholars and themselves are most interested. The paths of allied sciences cross each other in many ways and the joint meetings of the sections might be devoted to a careful consideration and selection of the problems and their assignment to different research centres by common understanding. At the annual session of the Congress there would be, under such a scheme, presentation of completed papers or preliminary communications of results on known subjects. Besides preventing duplication, men of science will be aware of the nature of work progressing in different research centres and will be able to obtain such information or assistance as they may require from those departments likely to provide them. Without unduly curtailing the freedom of the researcher, a definite policy such as this will ensure for every paper, that is read before the sectional meeting, a most complete and illuminating discussion. It is absolutely impossible to read and discuss fully all the hundred and fifty pieces of research now submitted to sectional meetings within the twelve hours at their disposal and consequently the scientific message of a large number of papers is practically forced to remain subconscious.

Perhaps one effect of the plan of carrying on work on a co-operative basis may be diminution in the number of papers. Though this is to be regretted it is hoped that the lack of quantity will be more than compensated for by the quality and the fruitful results of a complete discussion and free exchange of thoughts.

One other advantage that will result from a programme of the type outlined above will be the recognition of different centres as being associated with definite lines of research. Such places will also be recognized as centres for disseminating reliable and accurate information in those and related branches of science. Thus will spring up a series of *information bureaux* which will assist not only fellow-scientists with relevant literature and other technical information but also other members of the public interested in the utilization of such knowledge. In view of the bewildering increase in scientific literature during recent years and the inadequate library facilities at many of the research centres in the country, the importance of such an organization can hardly be over-estimated.

It seems to us that a federation of research centres under the moral countenance of the Indian Science Congress, directed on the principle of effective and cheerful co-operation, will produce results in the future in an increased measure and quite as brilliant as those that already stand to the credit of most Indian universities. The main idea is that a professor working on a problem should have the means of assuring himself that it is not also simultaneously engaging the attention of another professor in some other Indian university and that the schools of research into which the universities have already become differentiated should be more widely and practically recognized. Moreover, every research worker should have the fullest possibility of receiving information and assistance whenever he requires them. Under existing conditions, in which investigation is conducted in almost water-tight compartments, progress must necessarily be slow though a few have succeeded in accomplishing international distinction. But this is not enough to build up an Indian scientific reputation and tradition quite as honourable and enduring as those of any of the European countries. The intent of co-operative research must be to mobilize the intellectual resources of the country for the achievement of common ends. Apart from the Asiatic Society of Bengal and the Bombay Natural History Society, there are no institutes of science and learned societies such as occur in European countries, on an all-India basis and there are no all-India scientific journals for the publication of original papers in different branches of science. The existence of such national institutions is calculated to provide additional stimulus to greater endeavour than now and the possibilities of founding them would be a fit subject of examination by the Indian Science Congress.

The ideal of co-operative research is selflessness and self-sacrifice, without limiting opportunities of adding to one's individual reputation. If we assume that the tradition of a country is the history of its achievements made possible by common endeavour, then we are still a long way from establishing one for India. Suppose that it becomes feasible to establish a federation of research centres in India, the scientists concurring in a coordinate effort to lay the foundation of a new tradition, the furtherance of this object can only be secured by the institution of more than one all-India scientific journal for recording the total output of work produced in different branches of science

within her boundaries and by preservation of them in her archives. The question of international publicity and priority of announcement of discoveries, so essential for Indian science, need not necessarily present insuperable difficulties. The former is secured by the determination on the part of all the scientists working in the country to publish all their best results in India and the latter is most effectively secured through the facilities already available for them through *Current Science*. We have not the slightest hesitation in thinking that the greatest ideal of all the leading men of science in India is not so much to achieve personal triumphs as to dedicate their services for common interests, ideals and traditions. Given the right spirit and incentive to high endeavour, it would not be fantastic to suppose that before the next quarter of a century elapses the new generation of scientists in India will move for the grant of charter for the establishment of a Royal Society and in this task the present generation will have to pull together as pioneers. To the Indian Science Congress one must naturally look for the birth of great ideas and we are of opinion that the time has arrived for this representative unofficial body to conceive a nation-wide scheme of constructive programme of scientific work.

The growth of industries and commerce and urban life has already established an intimate liaison between their problems and those of science; and the next generation will emphasize this relationship even more strongly. The official research departments can no longer function independently of the universities which in their ultimate scope will be found to possess a common purpose. The problems of agriculture and forestry really belong to more than one branch of science and it is here that co-operative research may prove of great importance. The Indian Institute of Science should be more widely utilized by the universities and official departments than now for the advancement of the material prosperity of the country. The Imperial Council of Agricultural Research through a scheme of grants for research in applied and pure science, has already taken steps to enlist the co-operation of the universities with the laboratories of the official departments, and similarly the Indian Medical Research Fund Association is functioning in close co-operation with the Department of Public Health and other research institutions of medical science.

Unless the efforts of all these research centres converge towards a common ideal, the mass advancement of science itself must for some time remain a dream in India. It must be pointed out that the co-operative research that we suggest will neither hinder nor eliminate the opportunities for individuals engaging in special fields of enquiry. We are aware that an investigator starting to solve a problem in accordance with the principles of our scheme, may discover in the course of his work other ideas which will take him away from the original problem. This is decidedly an advantage to the scheme itself. There is no intention to put obstacles on the freedom of the research departments or to apply rigid rules to their methods of work by the advocacy of co-operative research.

The doctrine that, "neither science nor the people would lose much if no attempt ever was made to bring them together", should not commend itself to the local self-governing institutions whose problems need the aid of science in every detail and particular. Science indeed loses its entire significance if it does not establish an intimate contact with the vital forces of civic administration. In modern life it is becoming increasingly clear that science and society must collaborate for the fullness and enrichment of both, and science is deprived of none of its dignity by being associated with the problems of every-day life. The introduction of fast moving vehicles in India without a previous preparation of the road conditions in the cities has been the cause of certain wide-spread diseases of the throat and the eye from which, as the Reports of the Medical Inspection of schools and colleges have abundantly shown, a large majority of the school-going population is suffering. Traffic in the cities has become positively dangerous. The disposal of town refuse or its utilization is essentially a scientific problem. Town-planning, the distribution of wholesome water, the drainage system, the supply and control of unadulterated food-stuffs, the protection of people against outbreak of epidemics, the preparation and interpretation of vital statistics and a number of other municipal problems require the effective assistance of scientific research for their solution. The municipalities ought to take the fullest advantage of the universities and the Indian

Science Congress to which they should present their own local problems for investigation. In order to widen the scope of the usefulness of the Science Congress it may be deemed desirable to admit within its province the problems of municipal administration which directly concern the health and efficiency of the people.

Under the reformed constitution Indian scientists will be confronted with tremendous problems, and their preparedness to grapple with them on the basis of a common purpose and common understanding, must in a measure constitute the vindication of the general demand for the freedom of the country to progress.

Announcement.

WE have pleasure in informing our numerous readers that Sir Richard Gregory, Editor of *Nature*, will arrive in Bombay on or about January 19th, 1933, by the P. & O. SS. *Mongolia* and will be in India for about a month. He will be accompanied by Lady Gregory and hopes to visit Allahabad, Calcutta, Madras and Bangalore during his short stay in the country. Any communications intended to reach him on arrival should be addressed to Messrs. Macmillan & Co., Ltd., 276, Hornby Road, Bombay, and afterwards to their branches at Calcutta and Madras. We welcome Sir Richard A. Gregory and Lady Gregory to our country.

Effects of Temperature on the Determination of Size of Species.

By Dr. C. C. John, M.A., D.SC., D.I.C.

GRAY (1931) by his experiments on the eggs of *Salmo fario* has shown that the size of the embryo at the end of larval life is smaller at a higher temperature than at a lower. For the eggs of any given species of animals there exists a range of temperature within which the embryo is capable of developing into a normal healthy individual. If the temperature of incubation is raised, the rate of development of a cold-blooded embryo is increased and if the temperature is lowered the rate of development is retarded. Though the rate of growth at a higher temperature is more rapid, the final size at the end of larval life is smaller at a higher temperature than at a lower. This is because a larger proportion of yolk is required for the maintenance of the embryonic tissue at a higher temperature and only a smaller proportion is available for the formation of new tissue. Each of the many processes accompanying development is altered and a "new state of dynamic equilibrium is established" with the increase in temperature. These facts can be extended to a consideration of the development under natural conditions. The temperature of the seas increases as we proceed from the polar to the equatorial regions, so that the larvæ which develop under these different conditions are bound to show differences in size and the same conclusions may be applied to the adults also which develop from these larvæ. If this could be proved it means that individuals of any given species of aquatic animals (invertebrates and cold-blooded vertebrates) living under colder conditions will be larger than individuals of the same species in warmer seas.

The genus Sagitta is well suited for the verification of this fact, because of its occurrence in all the seas of the world under all conditions of temperature and depth, from the Arctic and Antarctic to the Equatorial seas. In a general consideration of the distribution of Sagitta the most disturbing factor is the difference in length of the specimens of any particular species obtained from different localities. For instance *S. enflata** obtained from San Diego region (Michæl, 1911) are about 15–21 mm., whereas the specimens collected at Madras are only about 11·5–13 mm. The same kind of difference is also noticed in *S. neglecta*. In fact all the species found to occur both in tropical and temperate seas show differences in length, the tropical form being always smaller in length, compared to those obtained from temperate seas.

There are some species such as *S. lyra*, *S. hæmata*, *S. macrocephala*, *S. elegans* and

* The Sagitta of the Madras coast have been wrongly identified as *S. bipunctata* (Shankara Menon, 1931). I was kindly permitted to re-identify the material and have been able to describe five species *S. enflata*, *S. gardineri*, *S. tenuis*, *S. neglecta* and *S. robusta*. Probably a few more species may be discovered by more systematic method of collection.

S. decipiens, which have been so far recorded only from cold water regions under conditions of temperature varying from 1·1° to 18·6°. Among these *S. lyra* has a total length of 18–48 mm. while the length of *S. elegans* is 21–23 mm. In comparison with these there are some species, which are restricted to the warmer seas (temperature, 21–29°), such as *S. neglecta*, *S. regularis*, *S. betodi*, *S. ferox*, *S. tenuis*, *S. gazelle*, *S. hispida* and *S. pacifica*. All these species are relatively shorter, for example, *S. neglecta* measures about 8–13 mm., *S. tenuis* 5–5·5 mm. and *S. hispida* 5·5–10 mm. Though all the species mentioned above are limited in their range of distribution there are quite a number of others, which show a cosmopolitan distribution, *e.g.*, *S. bipunctata*, *S. hexaptera*, *S. subtilis*, and *S. serratodentata*. *S. hexaptera* has been recorded between 70° N. and 40° S. at temperatures varying from 6° to 29° and *S. bipunctata* between 74° N. and 28° S. at temperatures varying from 0·2° to 31°. Among these two, *S. hexaptera*, especially, gives the best example of the influence of temperature on the determination of the size. The total length of *S. hexaptera* varies from 20–70 mm. Specimens obtained from the Gulf of Naples are about 20–25 mm. long while those obtained from colder regions are considerably longer, reaching upto 70 mm. in length. I was privileged to examine the collection of Sagitta of the "Discovery" expedition and the first thing which impressed me about the whole collection was the comparatively larger size of the specimens. Samples of *S. hexaptera* in this collection measure about 70–80 mm. These large specimens were obtained from regions beyond 40° S. and at depths ranging from 1,800–3,000 metres. The surface temperature in these regions varies from 8°–12°, but temperature at the depth from which these specimens were obtained is very much lower.

Though the data available at present are not sufficient for drawing up a statistical table, the general facts seem to indicate that in the colder regions Sagitta are comparatively long and that increase in temperature is accompanied by a corresponding reduction in size, in other words, the length of any given species of Sagitta in relation to its distribution is inversely proportional to the temperature of the locality from which the specimens are obtained.

For a study of the length of species in relation to temperature more than one factor is to be taken into account. Apart from its surface distribution Sagitta occurs at various lower depths, so that unless the depth of the catch and the temperature of that depth are definitely known it will be difficult to estimate the true relationship between temperature and size. If temperature does really influence the length of the species, then bathymetrical distribution is an important factor. It is one of the simple facts of Oceanography that temperature diminishes with depth, the bottom being always very much colder than the surface. Therefore, if in any locality a species of Sagitta shows vertical distribution the length of individuals obtained from markedly different depths are bound to show differences in length. But very careful systematic study of both Geographical and Bathymetrical distribution are essential before these facts can be definitely established.

Differences in the length of the larvæ may also be noticed in some aquatic forms of the temperate regions which produce two broods in the year. This is clearly seen in Herring (*Clupea harengus*) the common food fish of Europe. The Herring produces two broods, the autumn brood and the spring brood. The eggs of Herring are demersal, *i.e.*, they are laid at the bottom of the sea. They are hatched on the seventh day and the larvæ keep to the bottom for about three or four days till the yolk in the yolk sac is completely absorbed. The larvæ of the spring brood now migrate vertically upwards to the surface and from there to the coast, while the autumn brood behaves in a slightly different way. They never appear to leave the bottom but migrate shorewards without an intermediate journey through midwater. When the larvæ reach the shore the two broods are of different lengths, so that it is difficult to estimate age in relation to length, but it can be shown that at the stage when red blood appears some of the specimens are about 33 mm. and others 35 mm. long. (John, 1932.) This stage has been called the metamorphosing stage. If it is taken for granted that at the time of metamorphosis all the larvæ are of the same age the difference in length can be explained only by the difference in the temperature of the sea water in which the two broods pass their early development. The spring brood undergoes its earlier development through summer while the autumn brood passes this stage through winter.

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Agricultural Meteorology.

By Dr. L. A. Ramadas, D.Sc., *Agricultural Meteorologist, Poona.*

THAT weather has a great influence on crops is well known from the earliest times. The farmer has ever watched the skies anxiously for symptoms of coming weather for guidance in planning and prosecuting his farming operations. The experience of past ages has crystallised into popular weather lore handed down from generation to generation; but such information is necessarily empirical and of very local interest. As Sir Napier Shaw said in his opening address on Agricultural Meteorology before the Conference of Empire Meteorologists, Agricultural Section, 1929 (London), "Agricultural Meteorology is what the farmer knows and won't (or can't?) say". With the development of Agriculture and Meteorology as more and more exact sciences in recent times, we feel the need to-day of escaping from the limitations imposed by the vagaries of weather on farming and of exploiting with fore-knowledge the results of modern science in artificially improving the growth and yield of crops, in combating the adverse effects of fungi and pests and in protecting crops as far as possible from damage by bad weather either by inventing protective devices or by culturing weather-resisting types. It is the business of the Agricultural Meteorologist not merely to discover exactly "how much sun, how much warmth, how much rain was necessary for a bumper crop" but also to find out whether he can tell the farmer before-hand how much of these elements of weather he may expect in a given season. The State is also an interested party as it wishes to know before-hand, however roughly it may be, what the prospects of agriculture are likely to be and how much land revenue may be expected during a financial year.

Russia was one of the earliest countries to move in this direction and systematic observations of meteorological elements side by side with the growth and yield of different crops were commenced at a large number of experimental stations (the number of stations was 81 in 1912). The United States of America, Canada, Great Britain and most of the European countries have similar organizations for the study of Agricultural Meteorology and its practical applications to farming. The growing interest in the applications of meteorology to agriculture is also shown by the fact that before the War the International Meteorological Committee appointed a special Committee to study meteorology in relation to Agriculture. This Committee is now under the Chairmanship of Dr. Wallen of the Swedish Meteorological Service.

In India the Meteorological Department was instituted in 1875 to combine and extend the work of various provincial meteorological services which had sprung up before that date. The warnings to ships, ports, aeroplanes, etc., the daily weather reports, the monthly weather reports and seasonal forecasts for rainfall issued by the department are based on meteorological observations received by the forecasting centres from about 200 surface observatories. The observations recorded daily at these and a few more observatories for periods ranging upto 50 to 60 years are now available. The Department has also been responsible for technical supervision of rainfall registration at about 3000 stations in India, so that, on the meteorological side, there is available at present a very large mass of accumulated data for correlation with available crop data.

It will be recalled that two years ago, soon after his return from Europe after attending the International Meteorological Conference at Copenhagen and the Conference of Empire Meteorologists in London, at both of which Agricultural Meteorology was one of the subjects for discussion, C. W. B. Normand, Director-General of Observatories in India, placed before the Imperial Council of Agricultural Research a modest scheme on Agricultural Meteorology on the lines of the recommendations made by the Royal Commission on Agriculture in India (*vide* para 577 of their Report, 1928) so that India may fall into line with other nations which had already made a start. The scheme was sympathetically considered by the Council and official sanction was given early last year for giving effect to the scheme for a period of 5 years. Unfortunately the scheme had to be held up owing to the retrenchment campaign of the Government of India in 1931. The Government of India recently reviewed the research schemes sanctioned by the Imperial Council of Agricultural Research, and decided that rather than postpone the scheme of Agricultural Meteorology until the financial situation improves, it should be proceeded with on a reduced scale for a period of three years. The cost of the restricted scheme is roughly half of what was originally sanctioned. The New Branch began functioning in August last at the Meteorological Office, Poona.

The work of the new branch on Agricultural Meteorology will be under two heads: (*a*) Statistical, and (*b*) Experimental or Biological, but these two lines of enquiry are complementary to each other.

The programme of statistical investigation will begin with a critical enquiry of the available data on the area and yield of crops for the various presidencies and districts in India, and proceed, after careful selection, to correlate some of them with the accumulated meteorological data.

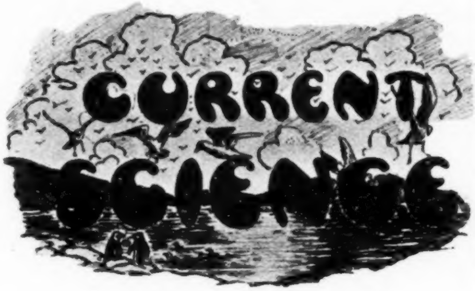
It will be one of the aims of the new branch to interpret the needs of the farmer to the weather forecaster and to tell the farmer in what way the

meteorologist could help him. There is no doubt that the daily weather telegrams which sometimes include 48 hours' warning of heavy rainfall and other phenomena may at certain seasons be of immense help to cultivators; but the problem is one really of the dissemination of this information with sufficient quickness so as to be useful to the recipients. This may require an elaborate and, for the present, impracticable organization involving the several departments as well as widespread W/T facilities in the country.

On the experimental or biological side there is a routine as well as a research aspect. In the routine work an essential preliminary will be to decide what meteorological and physical data ought to be collected regularly at all experimental farms for future correlation with the rate of growth and the yield of crops. The earlier investigations will also aim at the selection of the best methods and standardising them for the measurement of solar radiation, evaporation, soil temperature and soil humidity so that these data may ultimately be systematically maintained in addition to those of air temperature, air humidity, rainfall, wind, etc. The other problems will mainly be concerned with the meteorology of the air layers near the ground and the flow of heat and water through the surface of the ground. These investigations will enable one to understand the micro-climatology of different crops and to ascertain what fraction of the rain which falls from time to time at a place is actually available for crops (*i.e.*, the effective rainfall). Opportunities may also arise for joint work with Biologists and Mycologists, *e.g.*, on the effect of wind and evaporation, etc., on the plants, fungi, etc.

It is the intention of the new branch to seek the co-operation of various Agricultural Departments in order to arrange for detailed meteorological observations to be collected side by side with crop observations in at least a few experimental stations in most of the provinces. By close co-operation with the Agricultural College at Poona a model agricultural meteorological station is being evolved during the first year. This work will provide the basis for later extension of systematic experimental work on Agricultural Meteorology to a few selected experimental farms distributed over India. In this connection the need for careful standardisation of the meteorological instruments either already in use or to be used in different farms by comparing them with the standards of the Indian Meteorological Department can hardly be over-emphasized.

The programme before the new Branch of Agricultural Meteorology is indeed very formidable. The close co-operation of the various Agricultural Departments in discussing or studying problems of mutual interest will be invaluable to the Agricultural Meteorologist. With the scanty resources and staff now available it is recognized that the pioneer work of the new branch will be difficult; but the work done during the first three years will, it is hoped, prove to be the foundation of future systematic work on a scale more proportionate to the size of the country.



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The Indian Science Congress.

NO excuse is needed for making this issue of *Current Science* a special Science Congress Number. This Congress has become, during the twenty years of its existence, the one common meeting ground for men interested in all branches of science from all parts of India, and its meetings consequently, events of outstanding interest to readers of this Journal. *Current Science*, moreover, though not officially connected with the Congress, was started as a result of a discussion held during its last year's meeting. It is thus closely associated in its origin with the Indian Science Congress, and as both are intended to serve the same body of persons it seems likely that this informal association may continue and prove to be of the benefit to both.

The early history of the Indian Science Congress is recorded in the Proceedings of its Fifteenth Meeting in the Presidential Address delivered that year by Dr. J. L. Simonsen who had been largely responsible for its inception and early management.

After some preliminary correspondence, a meeting of seventeen of the foremost men of science in the country was held in the rooms of the Asiatic Society of Bengal under the Chairmanship of Sir Henry Hayden. This meeting decided that "The Asiatic Society of Bengal be asked to undertake the Management of a Science Congress to be held annually." But it was not till January 1914, that the first meeting was held in Calcutta with Sir Ashutosh Mukherjee as President.

The attendance was promising, though we should regard it as very small to-day and the total number of papers read was only a fraction of the number now presented to several of the individual sections. As was not unnatural, moreover, of these thirty-one papers twenty-five were from authors resident in Calcutta or other places in Bengal, bringing out very clearly the need for special facilities to enable members from all parts of India to attend as nearly as possible with equal facility. With the aid of the Board of Scientific Advice (since abolished) the Government of India were therefore persuaded to issue orders that selected officers from the various provinces, who could be spared, might be permitted to attend the meetings on duty. This, however, did not help those who were not Government servants, and in

their interests most of the Indian Railway Companies granted concession rates for the meetings. It is unfortunate that of these special facilities the latter was withdrawn during the war and has never been renewed, while the former is now severely restricted owing to general financial conditions.

The first Calcutta meeting resolved "That the Asiatic Society of Bengal be requested to publish for the present an account of the proceedings of the Congress and of such of the papers read as might be agreed upon by the Congress Committee and the Secretaries of the Society." The Asiatic Society of Bengal, founded in 1784 by Sir William Jones to enquire into "whatever is performed by Man or produced by Nature" within "the geographical limits of Asia", being (in spite of its name) an All-India Society with traditions and organization built up through over a century of steady work, publishing a Journal of world-wide circulation and reputation, and having among its members an influential body of men of science, was probably the only society in the country that could in this way give to the newly started Science Congress just the help that was needed to ensure satisfactory development. As a consequence the appointment of the Science Congress Secretaries was at first made subject to confirmation by the Society's Council, the Society's Treasurer was asked to be and still remains *ex-officio* Treasurer of the Congress and the Society's General Secretary was appointed and still remains an *ex-officio* member of the Congress Executive Committee.

Thus started and assisted in its growth, the Science Congress rapidly developed and its proceedings became so bulky that those of the tenth meeting (1923), though issued by the Asiatic Society in the same size and style as before, were treated as a separate volume instead of being incorporated in the Proceedings of the Society; and in 1926 the finances of the Science Congress were entirely separated from those of the Society.

During all these years the constitution adopted after the first few years of development remained in force with a few slight modifications. During the seventeenth meeting (1930), however, a special discussion of the constitution was held to voice a growing body of opinion that the time had come for the framing of a new constitution to suit the altered circumstances that had arisen as a result of the rapid and healthy growth that had taken place since those early days. As a result a sub-committee was appointed to look into the whole matter, and a carefully revised constitution was finally adopted at the eighteenth meeting, held at Nagpur in 1931.

The Indian Science Congress has thus become a well-established organization. What has it accomplished in the past? What should be its aims to-day? And how can these be best achieved?

Persons interested in scientific problems have met together annually to listen to or read an immense number of papers of varying interest and this is about all that can be recorded in its Proceedings. Judged by its printed record alone we doubt if anyone could regard the meetings of the Science Congress as worth the time and energy spent over them by secretaries, committees and members who leave their work and often travel great distances to attend. But the printed record can describe only the dry bones and not the life of the meetings to the maintenance of which they are, nevertheless, essential. As pointed out by Lord Pentland in welcoming the second meeting of the Science Congress to Madras, "We are all aware that the value of such meetings as this does not lie wholly in formal meetings, and that the opportunities of intercourse are perhaps as valuable as the formal meetings of such a Congress. It must be a great encouragement to the workers in science as well as in other branches occasionally to meet and compare results, to get to know one another, to have the many advantages of personal and social intercourse which a few days together must bring to isolated workers in so large a field, especially in so large an area as is represented by the term India."

We are inclined to go still further and to regard such opportunities of intercourse as probably the most valuable function of the Science Congress. And Dr. Simonsen gives this as the main reason for its foundation, saying that when he and Prof. MacMahon first arrived in India "Coming as we did from large English laboratories, we at once felt the great lack of any scientific intercourse. Not only was there neither in Lucknow nor Madras any scientific society, but in addition there was a complete absence of any scientific atmosphere. At that time, if we except the Asiatic Society of Bengal, the only opportunities afforded for scientific discussion were the somewhat irregular conferences promoted by the Government of

India, such as Sanitary Conferences or Conferences of Agricultural Chemists. These were purely official gatherings, and it occurred to Prof. MacMahon and myself that scientific research might be stimulated if an annual meeting of workers somewhat on the lines of the British Association could be arranged. We felt that not only would the direct personal contact of workers be of great value, but also that the general public would be brought to realize the importance and value of scientific research."

That the Indian Science Congress has amply justified its existence by the opportunities it has provided for personal intercourse between scientific workers is clear. But that the curtailment imposed last year on the facilities hitherto granted by Government to its servants to attend the meetings is bound to have unfortunate results in regard to this is equally clear and calls for immediate and careful consideration. It seems to us that the least that Government can do is to permit such of its servants as can be spared to attend on duty at their own expense, as some Governments did last year, and to urge all Universities and other bodies employing scientific workers to do the same. But in a country of the size of India this alone will not solve the difficulty. The holding of the meetings at a time which permits of members attending availing themselves of the Christmas concessions granted to the public by the railways has proved a suitable alternative to the special concessions for the meetings that were in force for a short time earlier on. The Science Congress is now so well established and scientific workers so keen to benefit from its meetings that these arrangements would doubtless suffice to ensure a large attendance. But it would almost certainly be found, as at the first Calcutta meeting, that workers from the more distant parts of the country were far too few adequately to admit of the personal intercourse between workers from widely separated places that so particularly need promoting, or even to provide proper continuity of personnel between one meeting and the next.

Something is evidently needed to facilitate the attendance of distant members, especially such as have long experience of the Science Congress and have proved themselves of special value in connection with its meetings. How this can best be secured it is difficult to see. The grant of travelling allowance by Government to its servants was a great help and would reduce the problem to much smaller proportions if it could be restored. But even this is not a complete solution, for its help is confined to those who are Government servants. We feel that efforts should be made not only to secure the renewal of this privilege to Government servants but also to encourage the formation of a fund, probably by donations and legacies, from which the Congress would itself give similar assistance to those permanent members who do not hold this position, especially such as are office-bearers in the different sections.

We feel, further, that the reading of a paper is not in itself a sufficient reason, nor even the most important reason, for the granting of such assistance. Indeed, we have even heard it suggested that the multitude of papers received, in certain sections particularly, good enough in themselves but of so limited an interest as to be more of a hindrance than a help to the progress of the meeting, has been in no small measure the result of a belief among Government servants that unless they had a paper of some sort to read facilities for attending the Science Congress would not be granted. That the value of a particular person to the Congress meetings, or of the Congress meetings to his work, is not at all necessarily connected with the reading of a paper will, we hope, be recognized and always be borne in mind by those with whom the granting of facilities to particular persons rests.

The second object for which the Indian Science Congress was founded has unfortunately not been by any means so fully realized. Public lectures, it is true, form a regular feature of the meetings, but to judge from the audiences they seem to appeal more to the members of the Congress than to the general public. This is, perhaps, inevitable as things stand at present and may well be regarded as more the fault of the public than of the Congress, but it is none the less regrettable.

In at least one instance, the foundation of the Madras Fisheries Department Marine Biological Station on Krusadai Island in the Gulf of Manaar, Government action in the interest of scientific workers and students has been initiated as the direct result of action taken by two of the sections of the Congress jointly.

Lastly, is it too much to hope that *Current Science*, born at the last meeting

of the Congress, may be instrumental in spreading abroad its aspirations and achievements among other news of scientific interest, more widely than is likely to be directly possible through any printed proceedings of meetings?

Presidential Address.

By Dr. L. L. Fermor, O.B.E., D.Sc., A.R.S.M., M.Inst.M.M., F.A.S.B., F.G.S.

I.—General.

To accept an invitation to preside over the Indian Science Congress is to accept a great honour, and I thank you gratefully, fellow-scientists, for this. But it is also to undertake a great responsibility, not the least portion of which is to deliver a Presidential Address at the commencement of the Session.

Before dealing with the special subject of my address, it seems desirable that I should first notice a few events and matters of interest or importance to scientists in India, including a reference to three of your Past-Presidents.

The first is Dr. Martin O. Forster, your President at the 12th Congress held in Benares in 1925. He is due to retire shortly from the responsible position of Director of the Indian Institute of Science at Bangalore, a post that he has held for over 10 years. As scientists, we thank him for the fruitful work he has done at Bangalore in supervising and stimulating the development of research; and as friends we wish him happiness and a further spell of usefulness on his return to England.

Dr. Forster is to be succeeded by Sir C. V. Raman, your President at the 16th Congress held at Madras in 1929. The high quality of Sir Chandrasekhara's work at the Indian Association for the Cultivation of Science in Calcutta and as Palit Professor of Physics at the University of Calcutta, and his inspiring leadership in the development of a school of workers in Physics, is a happy augury to the application at Bangalore of a further stimulus to scientific research at that southern centre. Calcutta's loss will be Bangalore's gain. At present Calcutta may be regarded as the centre of scientific research in India; but, with the transference to Bangalore of one of her leading investigators, she will have to guard her laurels.

The third Past-President I wish to mention is Lt.-Col. R. B. Seymour-Sewell, who is leaving India in April on leave preparatory to retirement from his post as Director of the Zoological Survey of India. We are not, however, at once to lose his services completely, for he has been appointed to lead the Sir John Murray Oceanographic Expedition to the Arabian Sea. Many of you are familiar with the results of the famous research expedition of H.M.S. *Challenger*, which, during the years 1873–76, explored the oceans of the world. The results of these researches are embodied in a monumental set of volumes issued over a period of nearly two decades under the editorship, first of Sir C. Wyville Thomson and later of Sir John Murray. The survey of the oceans was not, however, complete, the study of the Arabian Sea being omitted. Sir John Murray in his will left a sum of money for this survey, and now that it has been decided by his trustees to complete the task, they may be regarded as very fortunate in having been able to secure the services of Col. Sewell, with his wide experience of oceanographic research obtained as Surgeon-Naturalist to R.I.M. *Investigator*. We wish Col. Sewell every success in this new field of activity.

To one other scientist I must refer, namely, Sir Ronald Ross, who died at the age of 75 during the past year. You are all aware of his discovery of the method by which the parasite of malaria enters the human body, and of the enormous development in tropical medicine that has followed upon that epoch-making discovery. Ross' work was done in India and it has led to untold benefits to millions of inhabitants both of India and of other tropical countries. Sir Ronald left India before the foundation of our Congress, so that we have not had the privilege of his presiding over one of our gatherings. Nevertheless, we shall honour ourselves by recording our great loss in the death of one of the most distinguished scientists who has ever worked in India.

An event of major importance to the development of science in India during the past year was the decision made by a group of scientists during the last session of the Indian Science Congress at Bangalore to publish a scientific journal on the lines of

the well-known English weekly journal, *Nature*. A committee was appointed and eventually the publication has been commenced of a monthly journal entitled *Current Science*; the first issue appeared in July, 1932. You will all agree that the journal is a success, for there has been no lack of material suitable for publication and the journal is pleasantly printed on good paper. On one point, however, the Board of Editors have cause for anxiety. The University of Madras and the Indian Institute of Science have made grants towards the maintenance of this journal, and, in addition, there are receipts from the sale of the journal and from advertisements. The total receipts from these sources is not, however, sufficient to meet the total expenditure, and for its continuance the journal will require either additional grants from other bodies, or an increased number of subscribers. These are hard times and it is going to be difficult to secure donations from University bodies. But when I mention that the present year's budget of the journal has been framed on the basis of only 300 subscribers, which is less than one per million inhabitants of the country, and that 200 additional subscribers would square the budget, it will be seen that if Indian Science deserves the dignity of supporting an All-India journal in science, it can easily secure this dignity by what is really a trivial increase in the number of subscribers; for what are 500 subscribers amongst over 300 million people? No doubt, many of you have been waiting to see what the journal was like before subscribing. Now that you see the result, I hope that as many as possible will send in their subscriptions.

It has been suggested that as the Indian Science Congress may be regarded as the parent of this journal, the Congress should make a substantial annual grant to *Current Science*. This suggestion will no doubt be considered fully by the Council of the Congress; but we must remember that our Congress is not financially a profitable organization, and is itself dependent at each session upon generous donations from universities and other bodies and from the Local Government concerned, in augmentation of the subscriptions of the members of the Congress.

As this is the 20th Session of our Congress, introducing the 20th year of our existence, a few remarks on our progress may be appropriate. The history of the foundation and growth of the Indian Science Congress was given by Dr. J. L. Simonsen in his Presidential Address to the 15th Congress. This history can be accepted as authoritative, as Dr. Simonsen was, as you know, one of the Joint Founders of the Congress. From his address you will discover that the initial meeting that led to our formation was held in 1912 in the rooms of the Asiatic Society of Bengal, and that it was resolved that the Asiatic Society of Bengal be asked to undertake the management of a Science Congress to be held annually. The First Congress was held in Calcutta in 1914 under the ægis of the Asiatic Society of Bengal, and we have since been indebted annually to this Society for our resuscitation at each meeting. We have our own two General Secretaries upon whom much work falls, but two of the officials of the Asiatic Society of Bengal, namely, the General Secretary and the Treasurer, have all the time done very heavy work for the Congress, particularly in the publication of reports of our meetings and in keeping our accounts.

I use the word "resuscitation" because until 1931 our Congress had no permanent organization. In 1931, however, a constitution was adopted whereby we became a continuous organization under the title of the "Indian Science Congress Association" with a roll of permanent members, of whom at present we have about 225. In addition we recruit annually Sessional Members, Associate Members and Student Members. The administrative work of the Indian Science Congress Association is conducted by an Executive Committee of 11 Members, including the President, the retiring President, and two General Secretaries, the Treasurer (who is the Treasurer of the Asiatic Society of Bengal for the time being), and the General Secretary of the Asiatic Society of Bengal, who is really the Manager of the Congress and Editor of our *Proceedings*. In this way the historical connection between the Indian Science Congress and the Asiatic Society of Bengal has been put upon a permanent footing. This means also that the office of the Congress is in the rooms of the Asiatic Society of Bengal and that we receive the services of the General Secretary and Treasurer of that body free of charge. I have mentioned all this to indicate the extent to which the Indian Science Congress is a dependent body financially, and not yet in a position to provide donations towards laudable scientific enterprises such as *Current Science*, or

towards endowing particular researches in the manner undertaken by the British Association for the Advancement of Science in England. *Current Science* will no doubt eventually pay its way; but we could well do with funds for financing special items of research by private workers. We may hope perhaps that eventually donations for this purpose will be forthcoming from generous donors, who may perhaps remember the Indian Science Congress in their wills.

I have referred above to our *Proceedings*. As you know, the Proceedings of each meeting are now published annually by the Asiatic Society of Bengal as a special volume. This special publication dates, however, only from the 9th Meeting. The reports of the first 8 meetings were published as special parts in the *Proceedings of the Asiatic Society of Bengal*. This Society has now very generously undertaken to reprint, at its own expense, the Proceedings of the first eight meetings in a form homogeneous with the later reports. The Proceedings of the 1st, 2nd, 4th and 5th meetings have been issued and those of the 3rd are in the press. For financial reasons, the Society has found it necessary for the present to postpone the reprinting of the Proceedings of the 6th, 7th and 8th Congresses, but we may expect these eventually. In view of what I have said above it is evident that we have been very much beholden for a long period of years to the generosity and assistance of the Asiatic Society of Bengal, and I wish at this place to mention specially the name of Mr. Johan van Manen, the General Secretary of the Asiatic Society of Bengal, who has, for many years, acted as Editor of our *Proceedings* as well as helping in many other ways. It is also suitable that I should mention specially Prof. S. P. Agharkar, who has been one of our two General Secretaries since 1924, carrying on his duties in turn with Dr. Simonsen, Dr. Norris, and Dr. Dunnicliffe, and now with Mr. West, whom we welcome on the Executive Council of the Congress.

I have mentioned that this is our 20th year of existence. What is the object of our existence? According to our rules, the object of the Indian Science Congress is the "advancement of Science in India by the annual holding of a Congress". The advancement of Science may be effected in two ways. That which occurs first to our minds is undoubtedly the prosecution of research for the purpose of discovering new facts of Nature and, if possible, of explaining the meaning of these facts. But the advance of Science can also be helped by arousing the interest therein of the general public; for not only does our work conduce in many cases to the welfare of mankind, but it also requires the support of mankind in the provision of facilities and specially in the provision of finance. For both reasons, therefore, our Congress is in its annual activities a peripatetic body, meeting in turn in the principal cities of India so that each may become aware of our activities and our needs. This aspect of the scope of our activities may be summarised by the statement that in the first 20 years of our existence, we have met three times each in Calcutta, Madras and Bangalore, twice each in Lucknow, Lahore, Bombay and Nagpur, and once each in Benares and Allahabad, whilst we are now meeting for the first time in Patna. It is desirable also that we should cater for as many branches of Science as possible, not only by the creation of separate sections, of which we now have nine, which collect each the devotees of their own Science, but also in the Congress as a whole as represented by the President and his Presidential Address. It may interest you, therefore, to know that the first 20 Presidents have been distributed as follows: Medicine, Geology and Chemistry, three each; Botany and Zoology, two each; and Geography, Meteorology, Agriculture, Physics, Mathematics, Business and Engineering, one each. For the next—the 21st Congress—a Physicist has been selected.

The catholicity of our activities, both in place of meeting and choice of President, is illustrated by the foregoing figures. The extent to which this catholic behaviour and outlook has been successful is perhaps well illustrated by the astounding growth in the activities of our Congress. At the first meeting the number of members was 79, one Presidential Address was given, 35 papers were read, and the published *Proceedings* occupied 8 pages of print. Ten years later, at the 11th meeting, the number of Full and Associate Members was 403, with 290 Student Members. One general Presidential Address and 8 Sectional Presidential Addresses were given, 264 papers were presented, and the published *Proceedings* occupied 264 pages of print. At the 19th meeting, the number of Full and Associate Members was 690 and of Student Members 183. There were 10 Presidential Addresses, general and sectional,

and 693 papers occupying 467 pages of *Proceedings*. This growth in the attendance at our meetings shows increasing interest; but it is a question whether this vast increase in the number of papers presented can be desirable, for in the time available it is impossible to read more than a fraction of the papers offered. Thus at the 19th Congress 221 papers were presented to the Chemical Section; it seems unlikely that even a quarter of these can have been profitably read and discussed. Of course, this flood of papers reflects to some extent the activity of research in India in the branches of Science concerned, but one wonders if there is not some room for selection by the Sectional Committees of those papers that are most suitable for presentation at the Sectional meetings, taking into account the general interest and importance of each paper.

This growth in the activities of our Congress has been accompanied not only by a growth in volume but also in the number of recognized sections. The original 6 sections were Chemistry, Physics, Geology, Zoology, Botany and Ethnography. Agriculture was added at the 2nd Congress. The Physics section became the section of Physics and Mathematics at the 4th Congress, when Ethnography was also amalgamated with Zoology. At the 6th Congress the sections were increased to 7 by the addition of a section of Medical Research. At the 8th Congress, Ethnography was separated from Zoology again and made into a separate 8th section of Anthropology and Ethnography to become a section of Anthropology at the 9th Congress. At the 12th Congress a 9th section of Psychology was added, and these are our 9 sections now.

During the vast growth in the number of papers read at several of the sections, Geology has remained a small section, and the largest number of papers that has been presented at one meeting is 36. The relatively small number of papers offered in this Science is partly due no doubt to the fact that the meetings are held at a time when the officers of the Geological Survey of India are absent on field duties, and to geologists as a whole not caring to offer papers if they cannot be present to read them. Some other sections, *e.g.*, Anthropology and Psychology, also are happy in that a manageable number of papers is presented, and I commend the example of these smaller sections to the notice of some of their bigger brethren.

II.—The Place of Geology in the Life of a Nation.

This brings us to the end of my remarks upon matters connected with the progress and welfare of our Congress. I now propose to discuss in as general a manner as possible, a subject of more specialized interest, namely, the Place of Geology in the Life of a Nation.

Those of you who have pondered upon the relationship between cause and effect must realize that anything that happens now to any person or thing may be regarded as the latest unit in a continuous chain of cause and effect. And you will probably permit me to summarise epigrammatically the results of your thoughts by likening life to an algebraical equation.

As you know, an important feature of such an equation is that the sum of the items on the right side must equal the sum of the items on the left side. Life is rather like this. A present happening may be regarded as the right side of an algebraical equation, and all the events that have led up to this happening may be regarded as constituting the left side of the equation.

To take an example, the fact that I am addressing you this evening here depends upon the facts, among many others, that I was born on a certain date, that I took up the study of science, that I was diverted to geology from metallurgy, the profession I originally selected, that I secured an appointment in India, that I have remained in service until this date, that your council chose this place and date for our meeting and selected me to preside, and that I have succeeded in reaching this room without being involved in any accident. If any one of the facts mentioned had been different, I should probably not be here this evening.

An equation of this type, that is to say, one involving cause and effect, differs in one essential particular from the algebraical equations of our class rooms. The equations of our school algebra are static equations, whereas those of the type we are now discussing are kinetic ones. For on each side of the equations of life there is an energy factor implying movement in the past and the possibility of movement in the future.

It is this energy factor that conditions Evolution, which, using our simile, may be described as the grand and impressive kinetic algebraical equation of the universe, on the left side of which is included not only the magnificent succession of events constituting

the evolution of the stellar universe, but also the section of these events that has led to the evolution of the solar system and the birth of our planet; in addition it includes the much smaller, though to us vitally important, series of events that has led to the evolution of life upon our planet including the evolution of Man, followed by the still smaller series of events that constitutes the progress of human history down to its present point. The major portion of this grand series of events is the field of study of the Astronomer. With the formation of the earth, the field of study of the Geologist was provided. The evolution of life falls also within the realm of the geologist; but the latest section of this series of events, affecting human beings, falls within the sphere of studies of the Historian. The study of the present results of this evolutionary series of changes falls within the realms of Geography, Meteorology, Botany, Zoology and Anthropology, to mention sciences that in their historical or fossil aspect are comprised under geology.

You will now ask "Then what is geology and the true field of study of the geologist?" I cannot do better than quote the two opening paragraphs of Sir Archibald Geikie's 'Text-book of Geology':—

'Geology is the science which investigates the history of the Earth. Its object is to trace the progress of our planet from the earliest beginnings of its separate existence, through its various stages of growth, down to the present condition of things. Unravelling the complicated processes by which each continent and country has been built up, it traces out the origin of their materials and the successive stages by which these materials have been brought into their present form and position. It thus unfolds a vast series of geographical revolutions that have affected both land and sea all over the face of the globe.

Nor does this science confine itself merely to changes in the inorganic world. Geology shows that the present races of plants and animals are the descendants of other and very different races that once peopled the earth. It teaches that there has been a progress of the inhabitants, as well as one of the globe on which they have dwelt that each successive period in the earth's history, since the introduction of living things, has been marked by characteristic types of the animal and vegetable kingdoms; and that, how imperfectly soever they may have been preserved or may be deciphered, materials exist for a history of life upon the planet. The geographical distribution of existing faunas and floras is often made clear and intelligible by geological evidence; and in a similar way, light is thrown upon some of the remoter phases in the history of man himself.'

From this you will gather that geography is the branch of geology that describes the particular shape and form of the earth's surface at the moment. With the continuance of the operation of geological processes geography changes slowly through the ages, and looking backwards and making use of geological observations, we find that at previous periods in the earth's history the distribution of land and water, of mountain and valley, has often been vastly different from the present.

The geography of the earth at any moment including its climate, flora and fauna, and the inherent possibilities of further change, is, in fact, the right side of that kinetic algebraical equation, of which the left side is the geological history of the earth down to that moment. In fact, in mathematical parlance, the geography of the earth is a function of its geological history.

Those of you who have studied history, by which I now refer to human history, must have noticed the extent to which this history is related to geography: how coasts, seas, rivers, mountains and climates have exercised an important influence over the migration of races, and their struggles, one race with another, and upon the distribution of tribal and national boundaries. It is probable, nevertheless, that the majority of you have not realized that the guiding factors underlying geography were geological ones, and that, in fact, the events that constitute geological history have exerted a profound and far-reaching influence upon the history of mankind, both in general and in detail.

On the wall here is a geological map of the world.[1] The colours indicate the distribution of geological formations of different ages and origin. As you know, the land of the world occupies about a quarter of the surface, the oceans occupying the remaining three-quarters. According to some geolo-

[1] F. Beyschlag, 'Geologische Karte der Erde,' 1929–1932.

gists, the land area was once vastly greater, and according to most, the proportion of land and sea has varied greatly throughout the ages. One major deduction based on widespread geological evidence is that South America, South Africa, Australia, India and Antarctica were once all part of a continuous continent known as Gondwanaland. Views differ as to the method by which this continent was dismembered. According to one hypothesis, known as the hypothesis of continental drift,[1] the existing continents were grouped in Carboniferous times as one continuous land-mass, with all the existing parts of Gondwanaland in apposition to Southern Africa. Subsequently, on this view, the continuous land-mass was fractured, with drifting apart of the fragments to form the present continents. On this view, India was once attached to Africa near Madagascar, and gradually floated or drifted north-eastwards.

The second and older hypothesis, whilst accepting the fact of Gondwanaland, supposes that it was formerly a much larger continent than can be deduced by simply fitting the existing fragments together, that Africa and India were then at approximately their present distance apart, and that the separation of these two countries was effected by the foundering or sinking of the intervening portions of the continent. Some geologists find it difficult to visualise the machinery of foundering, and consequently support *in toto* the hypothesis of continental drift. Foundering can be explained, however, either by the compression of rocks underlying the sunken parts of the continent into a denser phase, *e.g.*, gabbro into eclogite,[2] or by the lateral underground squeezing of magma from below the foundering portions. Whichever of these hypotheses relating to the break up of Gondwanaland be true, the cause has to be found. I do not propose to discuss this here, but only to point to the fact that the existing fragments of Gondwanaland are now separate, and that India has sea-coasts that she would not have had but for this disruption. Mr. West proposes to discuss the hypothesis of continental drift in one of our evening lectures, so that I need not refer further to this question. As a side-issue I may mention, however, that the expedition that Col. Sewell is to lead to the Arabian Sea may obtain, if rock specimens in any quantity can be secured from the bottom of the ocean, evidence helpful to the determination of whether India has been separated from Africa by the foundering of the intervening land, or by drifting apart.

I will now invite your attention to these two maps of India, one geological and the other orographical. India is a large country, whilst the number of geologists who have been at work therein is small; in consequence, there are still great gaps in our knowledge, and our geological map is a very imperfect production. Sufficient, however, has been ascertained to reveal the general outline of the geology of India and to render possible a comparison between the geology and the orographical features as represented in these two maps. From this comparison you see at once that there must be some close relationship between the geology of India, that is to say its geological history and the present topographical features. From these maps you will see also that the Indian Empire, as at present constituted, is one of the most natural geological and physical units on the surface of the earth.

Geologically speaking, the Indian Empire may be regarded as consisting of three parts. There is first the Peninsula stretching southwards to Cape Comorin from its apex at Delhi; it is a remnant of the old Gondwana continent. To the north of this is the second unit, the Indo-Gangetic alluvium, composed of sands and clays, laid down, in geologically recent times, upon what is really a bent-down portion of Gondwanaland. To the north of this alluvium is the third unit composed of three mountain festoons with their convexities directed towards the peninsula. On the north-west is the first festoon composed of the arcs of Baluchistan and the North-West Frontier Province ; on the north is the second festoon, the magnificent arc of the Himalayas ; and on the north-east, is the third festoon, composed of the mountain ranges of Assam and Arakan and the Andaman and Nicobar Islands.

[1] Osmond Fisher, 'Physics of the Earth's Crust,' pp. 339, 380 (1889).
W. H. Pickering, *Journ. Geol.*, XV, pp. 23–38 (1907).
F. B. Taylor, *Bull. Geol. Soc. Amer.*, Vol. 21, pp. 179–226 (1910).
A. Wegener, 'Die Entstehung der Kontinente und Ozeane' (1922) : English translation (1924).

[2] L. L. Fermor, 'Preliminary Note on Garnet as a Geological Barometer and on an Infra-Plutonic Zone in the Earth's Crust,' *Rec. Geol. Surv. Ind.*, XLIII, pp. 41–47 (1913).

The northern edge of Gondwanaland is actually on the north side of the Indo-Gangetic alluvium, and lies in the outer ranges of the Himalayas; the Assam plateau may also be regarded as a fragment of this old continent; and as the Indo-Gangetic alluvium rests upon what must be regarded as a downwarped portion of Gondwanaland we can in fact reduce our elements to two, of which one is a fragment of Gondwanaland represented by the Peninsula of India, the Indo-Gangetic alluvium, the outer ranges of the Himalayas, and the Assam plateau. The other element is represented by the three mountain festoons of the north-west, the north and the east, which appear to result from the overthrusting of Asia on to this fragment of Gondwanaland.

There is a difference of opinion whether this relationship has been produced by the underthrusting of the Peninsula of India against the mountain lands of Asia, or by the overthrusting of the high lands of Asia on to Gondwanaland. The resulting Indian Empire, however, is an approximate geological whole with a crude bilateral symmetry about a N.N.E.-S.S.W. line that is reflected in the geography and orography of the Indian Empire. The exact outer limits of this Empire are, nevertheless, difficult to select on geological and, therefore, geographical grounds, and are dependent upon the details of history; but there can be no doubt that, looked at from a broad point of view, Burma, or at least the western portion thereof, must be regarded as an integral portion of the Indian geological and geographical unit.

General geological factors have thus given rise to a natural unit comprised of a hilly and wooded peninsula bounded on the west, south and east by seas and on the north by fertile plains, which are themselves limited by bordering mountain ranges to the north-west, north and east. The protective action of these bordering ranges would have been complete were it not for the operation of more local causes, such as faulting and river erosion in producing the gaps known as passes. The existence of these passes has had a profoundly important influence upon the human history of India.

Students of this history are aware that throughout the ages there has been a succession of waves of invading races that have taken advantage of the passes in the high mountain walls, specially on the north-west but to a small extent on the north-east; and they are aware how each successive wave of human invasion has pushed the remnants of the previous invasions further south into the Peninsula.

The fact that the Peninsula of India is bounded to the southward by seas was until a relatively late date in the history of India a limiting factor to changes in that history by providing a boundary beyond which the inhabitants could not be driven by further invasions from the north, and also by acting as an obstacle to the arrival of any disturbing invasions from the south. Later, however, this very factor of the existence of sea-coasts, once the Cape of Good Hope had been rounded by the Portuguese investigator Vasco da Gama, provided a means by which invaders from a far-distant part of the world, Europe, were able to reach India. Had, however, the disruption of Gondwanaland never occurred, the Peninsula of India would have remained embedded in a continent and would, consequently, have had no coasts; there would have been no European invasions by sea and the whole history of the country for the last few centuries would have been profoundly different.

As another instance of the manner in which the existence of the sea has reacted upon the history of India, attention may be drawn to the eastern festoon constituted by the Tertiary mountain ranges of Assam and Arakan. Had their continuation through the Andaman and Nicobar Islands to Sumatra and Java not been breached, these ranges would have acted as a barrier between India and Burma almost as effective as that between Tibet and India provided by the Himalayan ranges. The mere fact that the events of geological history have caused this range to be discontinuous with the isolation of the Andaman and Nicobar Islands and the provision of the sea passage from India to what is now Rangoon, led in an inevitable manner to the addition of Burma to the Indian Empire.

To illustrate still further the effect that geology may have upon the distribution of national boundaries, I invite your attention now to the geological map of Europe, though I regret that I have not been able to provide one on a larger scale. A comparison of this map, or of the corresponding orographical map dependent upon it, with the political map of Europe will reveal the extent to which national boundaries in Europe are based upon natural factors.

You will observe, for example, how the approximate position of the frontier between Spain and France is determined by the existence of the Pyrenees, which with the seas isolate Spain and Portugal as one natural unit. You will see how Italy may be regarded as another natural unit bounded by the Alps on the north and otherwise by the sea. Similarly, the Scandinavian Peninsula, composed of Norway and Sweden, is a natural unit: you will notice also that Finland is geologically allied to Sweden and not to Russia, so that it is not strange that Finland has succeeded in eventually obtaining her independence from Russia, although the national boundary between Finland and Russia is not in agreement with the geological boundary.

It will be noticed on the other hand that it is difficult to select on natural grounds a precise position for a frontier between France and Germany, as also for the frontiers of many of the countries of Central Europe. This lack of correlation between natural and national boundaries in Central Europe may, in fact, be regarded as the ultimate cause of the Great War, a more proximate cause being the ownership of the coal-fields and iron-ores of the Franco-German frontier lands. The broad truth is that in many parts of Europe nationality is on a smaller scale than geology and is consequently upon a precarious basis: from which it appears, if we may rely upon geology, that national stability will not be attained in Europe until the countries have in many cases been grouped into much larger units. The results of the partition of the Austro-Hungarian Empire as a result of the Great War provide an example of a particularly flagrant violation of nature; and economic grounds alone, it may be predicted, will eventually cause racial considerations to be subordinated to common economic interests resulting from physical factors.

Directing our attention once again to India we find we have here a country of the size of Europe without Russia, containing at least as many different races with at least as great a diversity as in Europe. India is fortunate, however, in that the general geological conditions have caused the inhabitants, in spite of their diversity of race, religion and language, to be welded, after struggles through the ages, into one political unit. As with national boundaries in Central Europe the boundaries between the provinces in India pay little attention in many cases to geological considerations. The province of Bihar and Orissa for instance, in which we are now meeting, is an excellent example of the violation of natural principles by provincial boundaries. But as long as a central political control remains, it does not matter seriously that the boundaries between our provinces take such little account of natural factors. Were the central control, however, removed and all political relationship to one general suzerain power severed, then the future history of India would again become as confused as it was in the past and as confused as that of Central Europe has been throughout the ages and promises to become again in the future.

I have suggested in the short time at my disposal the profound influence upon the history of a nation and upon the determination of its boundaries that may be exerted by geological factors, how relative national stability appears to be attained in cases where natural boundaries are based on physical features, and how the history of a country in respect of its extent and government appears to become confused and doubtful in cases where national boundaries have been laid down in defiance of physical considerations.

Leaving the general for the particular, I propose now to point to a few precise events and sets of conditions in India that can be ascribed to particular events in the geological history of the country.

In the first place we may refer to the position of the capital. There is no doubt that the defence of any country is one of prime importance, and that, therefore, the position of greatest internal strategic importance may have claims for selection as the capital of the country. A glance at this map will show you that Delhi, by virtue of its position at the apex of the Peninsula, occupies the most strategic point in India with reference to the internal peace of the country. For Delhi is at the point where the plains of the Indo-Gangetic alluvium that separate the Peninsula from the Himalayas become most constricted, the point consequently at which it is easiest to defend the fertile plains of the Jumna and the Ganges to the east against invasion from the west, the direction from which most of the major external invasions of the past have come. It is not surprising, therefore, that in the past history of India there have been three decisive battles at

Panipat[1] in the plains north of Delhi. It is this position at the apex of the Peninsula that caused Delhi to be the capital home of the Moghal Emperors and their predecessors, and which really caused the removal of the capital of India in recent times from Calcutta to Delhi.

But the welfare of a country does not depend only upon defence and politics. Commerce and industry are also of vital importance and, in so far as they are the true sources of wealth to a country, their importance may transcend military and political factors. It will be seen that a point somewhere in the delta of Bengal, by its connection with the Hinterland of the Gangetic valley and the highlands of Assam, its sea connection to Burma and Southern India, and its proximity to the coal-fields of Bengal, Bihar and Orissa, seems to be a natural site for a commercial and industrial capital; it is because of the existence of these underlying natural factors that Calcutta continues to be the commercial capital of India, in spite of the removal of the political capital to Delhi.

The ultimate factors that have caused upon the selection of Delhi as the political capital of the Indian Empire with the *de facto* retention of Calcutta as the commercial capital date back to the series of events that caused the break-up of Gondwanaland, followed by the elevation of the Himalayas and the deposition of the alluvium of the Indus, the Ganges and the Brahmaputra.

Another important item in the sequence of events following the break-up of Gondwanaland was the eruption of the Deccan Traps that cover some 200,000 sq. miles of Western India. For it is the eruption of these lava flows that is the real cause of the greatness of Bombay. Bombay depends mainly upon the cotton industry, and the latter is dependent upon the fertility of the black cotton soil derived mainly from these lavas. The foundations of Bombay were, in fact, laid, when the Deccan Traps were poured forth, let us say 75 million years ago.

Other events in the modern history of India can, however, be attributed to dates much more ancient than this; for example, the institution of the iron and steel industry at Jamshedpur in this province. This industry is dependent for its supplies of iron-ore and limestone upon deposits that were laid down in Archæan times, and upon deposits of coal laid down in early Gondwana times. We may ascribe an antiquity to these deposits of iron-ore and limestone of something between 600 million and a thousand million years, and to the coal an antiquity of some 200 million years. The foundations of the iron and steel industry at Jamshedpur were thus laid down at periods ranging from, say, 750 to 200 million years ago.

Numerous other examples could be cited of the dependence of particular events or industries upon past events in the geological history of India: but time does not permit.

The examples given all illustrate the manner in which geology has affected man, without his being conscious thereof: they illustrate the action of cause and effect in which mankind appears as the helpless child of geology.

There is, however, another aspect of our subject in which man derives conscious benefit from his geological heritage by utilizing the rocks, minerals and structures now lying at or near the surface of the globe. This may be described as the utilitarian side of geology, and this I have already discussed at some length in my Presidential Address to the Mining and Geological Institute of India in 1922 under the title of the "Utility of Geology to Man".[2]

It is unnecessary to enlarge upon this branch of our subject here, except, for the sake of completeness, to mention that on the utilitarian side geology helps not only in the development of mining and metallurgical industries, but also in many branches of engineering, both in the provision of materials and in structural problems dependent upon the strength and disposition of rocks such as those connected with foundations, with the study of landslips and earthquakes and with the alignment of railways. Further, as a result of the development of mineral and metallurgical industries, geology becomes the cause not only of revenue to Government in the shape of income-tax and royalties, but also of the creation of a widening circle of employment, starting from employment to miners and smelters and spreading out to employment for the great transporting agencies, the railways and shipping companies, to mention only a few of the interests that benefit.

[1] Babar defeats Ibrahim Lodi (1526); Akbar defeats the Afghans (1556); Ahmad Shah Durani defeats the Marathas (1761).

[2] *Trans. Min. Geol. Inst. Ind.*, XVII, pp. 16–40 (1922).

But should the conscious use of geology by man be confined to these directly utilitarian but relatively minor purposes? Should man not, as a result of his studies of the trend and influence of geological factors on a large scale, attempt so to adjust national and international life to these factors as to help the growth of national welfare and international peace; instead of, as so often happens, pursuing, in indifference to these natural factors, courses of action that tend to increase national or international disequilibrium?

It is mainly for utilitarian reasons, however, and partly, perhaps, because in addition it is realized that a country should know herself, that every civilized country maintains a Geological Survey Department for the purpose of ascertaining the factors upon which so much appears to depend.

I have already mentioned the approximation between the size of India and the continent of Europe without Russia. This was brought out forcibly in a map published recently by the *Statesman* in which Europe was treated as a jig-saw puzzle, and the countries of Europe excluding Russia were fitted into India excluding Burma. I show this map now upon the screen. It is difficult to secure exact figures of the strengths of the geological surveys of the various countries. But they amount to over 300, of which 78 are employed in Germany and 52 in Great Britain, whilst several of the less advanced countries, namely, Albania, Bulgaria, Esthonia, Latvia, Lithuania, and Turkey, appear to have no geological survey department. In India we have a staff of 24 for the study of the geology of the whole Indian Empire including Burma. Of these about 6 are employed in Burma, leaving 18 for the study of an area equal to that for which Europe provides over 300 geologists. Square mile for square mile, India is, of course, much less wealthy than Europe, but from the figures given above it is seen that if India is properly to know herself, she must contemplate in the future—it may be near or it may be distant—the employment of a much larger number of geologists than at present or than were employed before the recent drastic reduction in the strength of the Geological Survey of India effected as a measure of retrenchment. My faith in the value to a country of the work of geologists, coupled with the fact that in India in particular the accrued yearly direct and indirect financial benefits to Governments—Central and Provincial—is several times the annual cost of the Geological Survey Department, leads me to believe that re-expansion, followed by further growth, will eventually and inevitably be regarded as a vital financial necessity apart even from the influence of general and cultural reasons the importance of which will be increasingly realized.

I have alluded just now to the cultural aspects of geology. It will be readily apprehended that the study of a subject related so fundamentally to life is admirably suited for inclusion in university curricula. At present the scope for new employment for geologists in India has fallen almost to zero: but this does not mean that geological classes in University institutions should be closed. For young men should be encouraged to study geology not for the purpose necessarily of earning their living thereby, but as a branch of general culture, some knowledge of which is desirable to a man in whatever profession or walk of life he elects to earn his living. It is, in fact, not an exaggeration to say that no university that does not provide instruction in geology can truly and strictly be regarded as a university in the true sense of the word.

I have now reached the end of my address. In attempting to show the importance of geology in the life of a nation, it has not been my intention to magnify this science at the expense of others. All the sciences are inter-related, and geology in particular makes contact with many others, but specially with astronomy, meteorology, botany, zoology and anthropology, and also with the two sciences that deal with matter in its atomic and molecular aspects, namely, physics and chemistry. Moreover, we live in the present: the study of the present aspects of nature is, therefore, of as great importance to us as the study of nature in her historical aspects, with which geology is so greatly concerned. The importance of the study of the historical side of nature lies in the fact that such study helps us to understand how the facts of the present have arisen; and, because life is a kinetic affair, this historical study helps us to obtain sometimes a glimmering of the future, and even to suggest, however diffidently, the extent to which a measure of control of the future may lie within the grasp of mankind if we will but have the foresight and the courage.

Sectional Addresses.

AGRICULTURE :

THE acuteness of the present agricultural depression has been aggravated by organized, heavy crop-production in some parts of the World and introduction of synthetic substitutes for natural products in others. The pursuit of agriculture has, more or less, ceased to be remunerative and, considering the present conditions in the country, the future appears to be all but bright!

During the past thirty years, the agricultural departments of India have striven hard to effect various improvements; but in spite of the introduction of better implements and high yielding varieties, growing knowledge of suitable rotations and better facilities for irrigation and marketing, the situation has not appreciably improved—in fact, it has become worse as indicated by the increased suffering and greater indebtedness of the peasantry.

An analysis of the position shows that a large part of the trouble is due to our ignorance of the influence of environment on crop-yield. Successful crop-production is essentially the result of reciprocal reaction between the plant and its surroundings, but in our enthusiasm for the former we have overlooked the importance of the latter.

As an instance of the importance of environment may be mentioned the influence of season which (*a*) introduces greater differences in crop-yield than all the varieties introduced by man, and (*b*) so obscures the effects of manurial treatments that, in spite of three decades of experience, agricultural experts are still unable to give satisfactory advice to cultivators! Crops are often sought to be raised under soil and climatic conditions which are not generally favourable to them. Thus although the Punjab American cottons are superior to the indigenous *Desi* in length of lint, their ecological amplitude is narrower and hence their failure more frequent than that of the latter. Soil conditions, chemical as well as biological, also determine the success or failure of crops. It is a notorious fact that most Indian soils have reached the limit of maximum impoverishment but still high yields are expected to be obtained by the introduction of new varieties! Moreover, our knowledge of the reciprocal reactions of the soil, the crop and the micro-organisms is so limited that we rarely ever strike a favourable balance: thus, when off-season cultivation was attempted in the Punjab to eradicate the moth borers of rice, the yields went down by as much as 42 per cent! The concentration of carbon-dioxide in the atmosphere is also a factor determining the efficiency of plant growth but so far very little use has been made of this knowledge.

Every country—nay every tract—has to solve its own ecological problems. The problems of the Punjab are different from those of Bihar or South India and must be studied in full cognisance of the local conditions. This would apply particularly to the depredations of pathogenic organisms and insect pests which should be tackled in the same way as medical men forestall possible outbreaks of epidemics. The literature on plant pathology abounds with instances of allied phenomena showing the importance of environment in determining the abundance and distribution of various pests.

A striking example of the above is the Desert Locust which appears, in swarms, at intervals, spreading over Baluchistan, the Indo-Gangetic plain, Rajputana and West Central India, breeds for a few generations and then disappears. One naturally likes to know where the locusts come from, what they do during non-swarming seasons, why they migrate from their homes and in such large numbers and finally how to prevent the recurrence of their invasions in the future. The researches conducted by the author and his co-workers under the auspices of the Imperial Council of Agricultural Research show that: (*a*) the permanent breeding ground of the Desert Locust lies in parts of Baluchistan and the Indus valley; (*b*) that it thrives best in dry weather but perishes readily in a humid atmosphere, thus accounting for the rapid disappearance of the locust from the Gangetic plain shortly after every invasion; (*c*) that the rapid multiplication preceding their big flights is facilitated by a succession of seasons with good rainfall; (*d*) although when occurring in small numbers they are quite harmless, they turn out bold and highly aggressive during their flights; and (*e*) prior to their migrations the locusts multiply rapidly in their desert homes, shed their protective colouration and turn into dark hoppers. The above information, though not sufficient to eradicate the pest altogether, should still be helpful in warning the cultivators or otherwise minimising their depredations.

V. S.

ANTHROPOLOGY :

IN his Presidential Address at the Anthropological Section of the Indian Science Congress, Dr. P. Mitra refers in his introduction to the research thesis of a few of the Post-graduate Students as part of work for their M.A. and M.Sc. degree examinations, as also to the research work of the members of the Anthropological Department of the Calcutta University since its organization in 1921.

Research leads in India, says the President, saw the starting of linguistic classification of mankind with the Asiatic Society of Bengal. Pater Schmidt, Sten Konow and Grierson have, after their laborious researches, shown fresh fields for further investigations. The Austro-Asiatic or Pre-Dravidian problem is engaging the attention of scientists. The Dravidian linguistic problem is still unsolved, and the comparative study of Milanesian languages by Dravidian scholars may promise to open up fresh fields. The President then refers to the patriarchal theory of Sir Henry Main, Morgan's wonderful discovery of the relationship terms, and its correlation to the Dravidian and Senecan system for the solution of some anthropological problems. In his opinion a detailed and comparative study of some of the Australian and South Indian tribes is calculated to produce promising results for the solution of the Dravidian problem. Special emphasis is laid on the marriage systems of these tribes as helpful to the discovery of cultural affinities. The origin of exogamy, in the opinion of the President, is still

shrouded in mystery in spite of the numerous theories that have been formulated by the various anthropologists and the ancient Hindu rishies.

The President gives some parallelism between the early developed culture in Northern India and Polynesia. Further the stratic graphic study of culture in the line of the German school and mapping out of culture areas are recommended. Definite distribution of traits of a culture complex is far more yielding of results in the fields of material culture. The study of material culture traits common to India, Africa and the Pacific might lead to produce types which are likely to have originated in a central home before dispersal.

The recent studies of Dr. Broom in South Africa reveal the probable existence of a South African Australoid race who have left similar physical traits. In the opinion of the President, India can be studied in comparison with the data from Africa on the one hand and the Pacific on the other. The implements in South India and Tasmania are said to be similar. As probable survival of the early stone age culture complex, boomerang plays a prominent part. Griebner in his classic study of the Milanesian bow culture has shown five stratifications of which the old Australian culture with boomerang was the earliest, and this was followed by totemic culture, and then a matriarchal dual organization after which came the boomerang bow culture complex and still later the Polynesian culture. The boomerang, says the President, is common to Africa, India and to Australia, as may be seen from the specimens exhibited in the Pitt-Rivers Museum of Oxford. Similarly the study of the bow will also yield valuable results.

The study of the problem relating to the dispersal of taro and banana and of domesticated animals, study of culture of intercontinental regions will reveal important role of India as primary or secondary centre of diffusion of cultures in several stages of her culture complex in the march of time. The study of the origin and development of plough yields important results. Finally India has to take inspiration from her cultural patterns so as to be able to combine with the cultural traits of the West and break into new paths. Finally he concludes his address by referring to some super anthropological problems.

L. K. A.

BOTANY:

THE study of algæ did not receive for a long time the attention due to it from Indian botanists. One main reason for its neglect is the general impression that a study of this group of plants can hardly be of any economic value. So, while Mycology, Plant-Breeding and Plant-Physiology are drawing most of our men, subjects like Algæ which are supposed to be of academic interest only fail to attract any of them. It is gratifying to see, however, that of recent years more people are taking to the study of algæ. An attempt is made in this address to show among other things how a study of algæ, besides throwing valuable light on fundamental biological problems, can also be of value economically.

It is generally believed that life first originated in water and that the first living organism must have been of an algal type. And a detailed study of these plants will throw light on the problem of the origin of life, the solution of which is the ultimate goal of all biologists. Again a study of this group will enable us to understand many biological principles such as division of labour, parallelism in evolution, the phenomena of differentiation of somatic and reproductive cells, origin of sex, alternation of generations, adaptation to land life, etc. And the structure, function and origin of cellular bodies like the nucleus, plastids, pyrenoids, blepharoplasts, chondriosomes and golgi bodies are more likely to be understood by a careful study of this group of plants than of any other.

The different systems of classification of algæ are briefly dealt with, particular emphasis being laid on the flagellate origin of algæ, the main differences between the *Isokontæ* and the *Heterokontæ*, the parallel evolution seen in both these two groups and the existence of "flagellate" and "algal" forms in all the main algal groups. Reference is made to the works of several algologists on these simplest types of algæ and the desirability of work being done in India on similar lines is emphasized.

The work done on the ecology of algæ by several workers like West and Pearsall, Naumann, Fritsch, Donat and others is briefly described. Among other points, the ecology of freshwater lakes as described by these authors is explained in some detail. The classification of lakes as under Oligotrophic, Eutrophic and Dystrophic ones is explained and the effects of various factors such as the depth and form of the lake, the sediment, the hydrogen-ion concentration, the surroundings of the lake, etc., on the nature and composition of the algal population are described.

The ecology of subærial algæ is next described and an account is given of the important role these algæ play in colonising new and inhospitable strata, which are thereby rendered more habitable for higher plants. The need for research work on the ecology of algæ in India is pointed out.

The possible lines of work on the cytology of algæ in India are referred to, particular emphasis being laid on the possible presence of structures similar to Golgi bodies and mitochondria in algal cells.

Lastly, the economical aspects of the study of algæ are dealt with in some detail. The value of algæ on the growth of fishes is briefly explained. The algæ form the food of minute animals, which in their turn form the food of larger animals, which in their turn again serve as food for fishes, so that possibility of fish-life in any area is ultimately dependent on the presence of these minute lowly plant organisms. Investigations on the algal population and the various physical and chemical features which control their growth will help to control the nature and extent of the fish-population in any area.

The need for the establishment of freshwater biological stations for investigating hydrobiological problems in India as has been done in other countries is pointed out.

The study of algæ in relation to agriculture is next dealt with and the importance of determining whether the algæ growing on cultivated soils are beneficial or harmful to the crops is pointed out.

Many scientists have adduced evidence to suggest that the algæ are able to fix the free atmospheric nitrogen. If this should prove to be true, the growth of the algæ must be encouraged on the fields.

The study of algæ is necessary in connection with town water supplies. In the reservoirs there is usually a fair amount of algal growth. The physical and chemical conditions of the water in the tanks and the nature of the algal population should be studied, and, when necessary, measures should be taken to check or altogether eliminate the growth of the algæ in order to ensure a pure water supply.

Many mosquito larvæ depend on algæ for their food and hence there is a possibility of checking the growth of the larvæ by controlling the growth of the algæ. It is reported that mosquito larvæ do not flourish in waters in which *Characeæ* are growing. If this should prove to be correct, then we have another method of getting rid of the larvæ.

Algæ are used as manure in Rajaputana, as they are very rich in nitrogenous material. It is not known whether they are used for a similar purpose in other parts of India. Characeous deposits are used as manure in Switzerland. Moreover, the peculiar odour emitted by them is said to help in keeping the soil free from insects.

M. O. P.

CHEMISTRY:

IN the first part of his address Prof. Neogi draws attention to an analysis of the causes which have led to the remarkable increase in the output of original work in chemistry throughout India during the last 20 years. Sir P. C. Ray along with Sir Alexander Pedlar and Dr. Richardson shares the glory of being among the pioneers of chemical research in India. Every paper of Sir P. C. Ray was commented upon by newspapers of the country, thirty years ago, as proof of the capacity of Indians for original work in chemistry but at the present day, only the most outstanding discoveries like Raman Rays attract the attention of the Indian public. The principal causes which have contributed to this change are: (1) the establishment of post-graduate departments in most Indian Universities; (2) expansion and consolidation of purely research institutions like the Indian Institute of Science at Bangalore and technological departments in some Universities; (3) establishment of industrial and scientific departments by provinces and native states; (4) institution of the M.Sc. and D.Sc. degrees with fellowships and scholarships for research in many Indian Universities. But as important as any is the formation of the Indian Science Congress through the efforts of Professors J. L. Simonsen and P. S. MacMahon whereby different workers throughout the country were brought into touch with one another more closely and inspired the youth to emulate the work of the elders. Research has kept pace with the growth in opportunities for work, these thirty years. Dr. Neogi suggests the institution in Indian Universities of the Ph.D. degree for original work after M.Sc. stage, though still assisted by the teacher and pleads for greater help to the research student by a larger number of liberal research scholarships in Indian Universities, similar to those prevailing in the Indian Institute of Science at Bangalore.

The next portion of the address gives an account of optical isomerism as applicable to co-ordinated inorganic compounds. Optical isomerism was, as is well-known, explained by Le Bel and Van't Hoff in 1874 by the tetrahedral space arrangement of carbon linkages. In the next few decades, numerous classes of optically active compounds of elements other than carbon, such as N, S, P, As, B, Sn, Pb, Si and inorganic co-ordinated compounds of Co, Cr, Be, Pt, Ru, Rd, Ir and Pd were discovered and their isomerism explained by the newer conception of the arrangement of atoms in space. Werner was the pioneer in extending the conception of space representation to co-ordinated inorganic compounds. He and his co-workers soon discovered that (1) a co-ordination complex usually contains six monovalent groups round the central metal atom; (2) compounds containing complex of the type $[MA_6]$ or $[MA_5B]$ do not exist as isomers; (3) cis- and trans-isomerism exists in compounds containing complex of the type $[MA_4B_2]$ or $[MA_4BC]$; (4) In such cis-compounds if A_4 be substituted by two radicals, like oxalato or ethylenediamine, each occupying two co-ordinate positions in the complex, the compound will exhibit optical isomerism. In a complex of the type $[MA_6]$, A_6 be substituted by three radicals like oxalato or ethylenediamine, each occupying a double co-ordinate position, such complex will also exhibit optical isomerism.

The repeated occurrence of co-ordination number six among the complex salts led Werner to suppose that the substituents were placed at the corners of a regular octahedron having the central metal atom at the centre. He was able to prepare all the ten theoretically possible cobaltic-dinitro-ethylenediamine-propylenediamine compounds and all the twelve trispropylenediamine compounds in agreement with the octahedral structure. Varied and extensive experience and X-ray examination has overwhelmingly confirmed this view. The first optical isomers were isolated by Werner and Kling in 1911 and thus this branch of chemistry is only of 20 years' growth.

The first active co-ordinated inorganic compound contained cobalt as the central element. Soon Werner was able to isolate active complex compounds containing other elements of groups VI and VIII Cr, Fe, Ni, Ru, Rd, Pd, Ir and Pt. Recent work of Mills, Lowry, Wohl and others proves that elements of other groups, Cu, Be, Zn, B, Al and As also yield co-ordinated compounds. The resolution of hexol-dodecammine-tetracobaltic bromide $\{CO[CO(NH_3)_4(OH)_2]_3\}Br_6$ by Werner (1914) into *d* and *l* forms gave a blow to the belief that organic radicals are essential for optical activity in co-ordination compounds.

Both Le Bel and Van't Hoff postulated in the case of carbon compounds that, for optical activity to occur in a molecule, it must have at least one carbon atom attached to four different radicals. Later work as that of Pope, Perkin and Wallach (1909) on 1-methyl cyclohexylidene-4 acetic acid showed that the doctrine of the asymmetric atom is no longer a fundamental concept but is only a part of a wider truth. The successful resolution of cis- or tris-ethylenediamine or similar compounds which do not have any asymmetric atom, brought out

the fact that the indispensable condition for optical isomerism is that the molecule of the compound should be asymmetric and non-superposable with its mirror image. Thus Werner's work confirmed the inadequacy of the Le Bel and Van't Hoff's theory of the asymmetric atom.

In the resolution of racemic co-ordinate inorganic compounds all the three methods discovered by Pasteur have been tried. There is no record of any successful resolution by living organisms, bacteria or moulds. Only one instance of self-resolution by spontaneous crystallization is on record, *viz.*, that of Potassium Cobalti-oxalate by Jaeger and Thomas (1918). The remaining method, resolution by combination with active compounds, has been exclusively employed with inorganic compounds.

Search for an analogous compound of the tartaric acid type resulted in the discovery in 1913 by Werner of tetraethylenediamine-μ-intro-μ'-imino-dicobaltic-bromide which along with *d* and *l* forms, yielded a meso variety incapable of resolution. The phenomena of racemisation and mutarotation which have both been observed with active inorganic compounds, have not found lucid explanation and still await further work.

No comprehensive work has been done on the influence of solvents on the rotation co-ordinated compounds and work leading to a decision on the applicability of Landolt-Oudeman's Law to them is certainly desirable. Jaeger (1915) who examined their rotatory dispersion found that the form of the dispersion curve is dependent on the colour of the solution and chiefly on the complex.

But for some work by Werner, the phenomenon of Walden Inversion has been little studied in this group. The theories advanced for inversion of organic compounds may not be applicable here due to their octahedral structure and the absence of double bonds.

The phenomenon of geometrical inversion which has engaged the attention of Dr. Neogi in recent years has been dealt with at length and is met with in two forms in the inorganic group : (1) ordinary cis-trans, transformation ; (2) inversion in which there is a transference of radicals from inside the co-ordination to the outside and *vice versa*. The latter form of inversion is so characteristic of these compounds that Dr. Neogi proposes for it a new name—Werner Inversion—and has undertaken to deal with it in greater detail elsewhere.

It is not generally known that the trophy for the highest specific and molecular rotations lies with the inorganic compounds, the values for *l* dodecammino-hexol-tetracobaltic bromide being —4500° and —45,000° respectively. There are still many gaps in the study of optical isomerism in inorganic compounds and Professor Neogi invites the votaries of both the branches of chemistry to the task of completing the work which was started so ably by the immortal Alfred Werner.

B. S.

GEOLOGY :

PROF. N. P. GANDHI's address deals with two topics of great interest to geologists as well as to workers in other branches of science. After indicating the aims and objects of pure geology, its cultural value is brought out with special reference to classical hypotheses like those of Hutton and Playfair. The 'contacts' of geology with other branches of science and the additions to knowledge accrued thereby are exemplified by the controversies regarding the age of the earth and the nature of its interior. The neglect of geology by Indian Universities is inexplicable particularly when considering that geologists can carry out very valuable work either in industrial concerns or in Universities. Effective remedies are suggested for securing due recognition to geology in University curricula.

The second part of the address deals with the organization of Mineral Research in India. Instances are cited of international movements of minerals and mineral products which have resulted in 'overdevelopments' of minerals and this is characterized as waste—'physical waste of raw materials and equipment, economic waste, employment waste and social waste'. To remedy the defects in the mining industry of India a five-year plan is suggested to deal with industrial mineral research by an organization similar to that prevailing in America. Attempts should also be made to educate the public by supplying suitable information on various aspects of Indian geology in popular language, well illustrated and distributing them at a nominal cost. The address concludes with a strong appeal to focus public attention on the important and urgent questions relating to the mining industry of India.

MATHEMATICS AND PHYSICS :

DR. A. L. NARAYAN's address naturally concerns itself with recent developments in Spectroscopy, the subject to which Dr. Narayan and his co-workers have principally devoted themselves during the past several years. A wide range of topics has been surveyed, including vector coupling, vacuum spectroscopy, Hyperfine structure, Molecular structure and the Raman Effect. Application of Physics to the study of the heavenly bodies also comes in for particular mention ; the origin of the auroral green line and of some lines in the spectra of the corona and of the Nebulæ are discussed in this connection. The application of the Raman Effect to the verification of Boltzmann's law of distribution of the different states of energy of molecules and to an ocular demonstration of the dissociation of electrolytes is also dealt with.

Taking first the question of vector coupling in atomic spectra, the two extreme types, *viz.*, l-s and j-j coupling, are discussed, and the criteria available for distinguishing between these types, *viz.*, the positions of the energy levels, the intensities of the inter-combinations and the Zeeman Effect, are then detailed. It is recalled how in actual cases the coupling is mostly of an intermediate type so that a distinction according to one or the other of these extreme cases becomes well-nigh impossible. Expression is then given to the conviction that a study of some of the more complicated Spectra is bound to lead to further advances just as the study of simpler cases paved the way for some of the most important modern advances in Physics.

The next topic to be referred to is vacuum spectroscopy of the extreme ultra-violet and the importance of this to the study of the spectra of "stripped atoms" initiated by Millikan and Bowen. The method of using a grating at grazing

incidence developed by Siegbahn at Upsala for a study of very soft X-rays is then described. The best sources of radiation for work in this region are then examined and it is shown that the Geissler tube possesses many advantages. The hollow cathode method developed by Paschen and Schüler is also very convenient for this purpose as well as for hyperfine structure work.

Coming next to hyperfine structure, its significance for a study of the nucleus and isotopic constitution is mentioned. The work of Hargreaves, Hill, Back and Goudsmit is discussed and in view of the paucity of the present data and the divergences between various workers, the necessity for much further investigation is pointed out. Details are then given of the systematic study of the arc spectra of Thallium and Indium and the spark spectra of Arsenic and Bromine by Dr. Narayan and Rao. The source was a cooled cathode arc of the type described by Venkatesachar and used by him in this line of work. The hyperfine structures were examined by means of quartz and glass Lummer plates and fused silica etalons. The results differed from those of McLennan and Crawford as regards the number of components and the existence of isotope shift in the lines 5351 and 3776 of Thallium. An extra component which has no place in the level scheme was also found in 3776. Results of an investigation of the hyperfine structure of the spark spectrum of Arsenic are also given and show deviations from those of Tolansky.

Touching next on the intensities of spectral lines, the rules governing the intensity relations in multiplets are alluded to and an attempt to compare these relations in emission spectra with those obtaining in the Solar spectrum using the lines of Nickel is then described. The results show that stronger lines appear relatively much stronger, in contradiction to the conclusion of Woolley that weaker lines appear relatively stronger.

Saha's theory of thermal ionization is discussed and its success in clearing up a number of problems in Astrophysics is pointed out. This leads then to the mechanism of the chromosphere and of the prominences on the sun's limb. Photographs of the prominences in K and Hα light were found by Royds to be nearly identical and this is shown to necessitate a revision of the present ideas of the mechanism of these prominences.

The problem presented by the green line in the spectrum of the Aurora and the Night Sky is then referred to and McLennan and Shrum's interpretation of it as due to a transition from the metastable $^1D_2$ to the $^1S_0$ state of oxygen and their production of the entire auroral spectrum by means of a discharge in a mixture of oxygen and the rare gases are described. The fact that whereas Lord Rayleigh and McLennan found that the intensity of the green line in the spectrum of the night sky reached a maximum about an hour after midnight, Ramanathan found it to be the reverse, is mentioned as likely to throw much light on the structure of the upper atmosphere in our latitudes.

Regarding the spectrum of nebulæ the interpretation of the lines 7325, 6584, 6548, 5007, 4959, 4363, 3726, 3729, as $^2D_{23} - {}^2P_{12}$ (O II), $^3\bar{P}_2 - {}^1D_2$ (N II), $^3\bar{\bar{P}}_1 - {}^1D_2$ (N III), $^3\bar{\bar{P}}_2 - {}^1D_2$ (O III), $^3\bar{\bar{P}}_1 - {}^1D_2$(O III), $^1D - {}^1S_0$ (O III) $^4\bar{S}_2 - {}^2D_3$(O II), $^4\bar{S}_2 - {}^2D_2$ (O II) respectively, finds mention and Hopfield's production of the lines 6300 and 6364 is noted as the only successful attempt to produce nebular lines in the laboratory. The origin of the coronal lines is also yet obscure but a hope is expressed that it may be elucidated in the near future.

Next dealing with molecular spectra, Dr. Narayan notices the advances made during the last few years, the importance of the aid rendered by the study of the Raman Effect to a knowledge of molecular structure and the success of the new quantum mechanics in predicting the half integral numbers involved in band spectra, and the transition rules in molecular spectra.

The proof of the Boltzmann law of distribution of energy states from a study of the intensities of the Stokes and anti-Stokes lines in the Raman Effect is then dealt with. The initial qualitative results of Raman and Krishnan in CCl_4 and the later quantitative work of Ornstein and Rekveld are mentioned as providing a proof of the correctness of Boltzmann's law. The address concludes by referring to the work of K. R. Rao on the changes in the intensity of the Raman lines of electrolytes with increasing dilution, and that of Bhagavantam on the spin of the photon carried out in Raman's laboratory.

T. S. S.

MEDICAL AND VETERINARY RESEARCH:

IN the course of his address Lt.-Col. A. D. Stewart dwells first on the recent recognition of Preventive medicine as a branch of general science. He then proceeds to consider the place of Scientific medicine in human life.

"Medicine was first associated with religion which allowed of its rapid development in the earlier stages but stifled independent speculation and investigation and experiment. Later, medicine broke the bonds of doctrine and dogma; the names of Harvey, Koch, Manson, Ross and Ehrlich are some of the names associated with brilliant experimentation. But the real human touch and sympathy which brought medical science close to the human race was due to the combination of Harvey, the experimentalist, Chadwick, the legislator and Wesley, the humanitarian. Since then the boundaries of medical science have been tremendously widened. 'Man is a personality and an entity—the combination of body, mind and spirit.' The conception of health now is to envisage the full development of these powers, physical, mental and spiritual of which man is possessed. The development of our modern conception of public health is logical; care of the body first, then mind and then spirit."

"We are realizing now the importance of studying the mind. The Alderian doctrine of reaction to environment—occupational, social and sexual, has made us realize some of the problems of affection of the mind."

"Hygiene and other euthenic measures have prolonged the average length of life in many countries and it must be emphasized that the expectation of life does not merely mean that of body but also of mental powers. Medicine and science are beginning to make a profound appeal—aesthetic and religious—to thinking

people ; the care and the development of the spirit is for future of these sciences. Man is mortal, and he feels disappointed with the shortness of his existence. Goethe wrote very truly, 'The spectacle of nature is always new, for she is always renewing the spectators. Life is her most exquisite invention and death her expert contrivance to get plenty of Life.' The only real objection is to premature death, so distressingly common."

"To the question that the thinking man puts himself regarding the purpose of life, my own answer is that in the quest and appreciation of truth and beauty, in their largest sense and meaning, is the best answer to life's purpose,—the one that gives the greatest satisfaction. Einstein says, 'To ponder interminably over the reason for one's own existence or the meaning of life in general seems from an objective point of view to be mere folly ; and yet everyone has ideals by which he guides his aspirations and judgment. The ideals which have always shown before me and fitted me with the joy of living are Goodness, Beauty and Truth.'

"Formal religion has not satisfied the thinking man, and for the pursuit of truth, we look to science ; but it is the poet who helps us most in our appreciation and search of the beautiful. Two medical men who later became poets, *i.e.*, John Keats and Robert Bridges have given the most notable contributions to the English language exemplifying the eternal principle of truth and beauty in life. Keats wrote, 'A thing of beauty is a joy for ever' ; and 'Beauty is truth, truth beauty.' Bridges at the age of 86 wrote the 'Testament of Beauty' ; he was a qualified doctor."

"Symbiosis and parasitism are two natural processes which have immense significance for the public health worker. True symbiosis is progressive, as it leads to the mutual aid. Parasitism is a degrading influence, injurious to the host, later possibly leading to death of the host. Parasitism is the chief obstacle in man's onward progress ; obliteration of human parasites in India will be for some time the main task of the public health worker. It may be possible for man at some future date by evolving his mind and personality so as to obtain control of the genes in his chromosomes to produce human beings with finer minds and better-built bodies, but this is for the future. The immediate task is abolition of parasitism."

"The instinct for desire for truth and beauty is inherent in everyone, the medical man has got great advantages as his profession leads him to study nature and man. Planck, the celebrated Physicist, considers that the study of nature fosters the two noblest of impulses of human mind—enthusiasm and reverence. Our strongest response to nature when we listen to the 'still sad music of humanity' is to awaken the sense of pity with human aspirations, human suffering and human needs."

"Pity is one of the strongest forces behind public health work and preventive medicine. It has, however, the defect of its qualities. Pity is of its nature combative, it may outrun discretion and reason, and have an un-reasoning contempt for consequences and counting of costs. It may engender a spirit of recklessness, impatience of opposition and even fanaticism and ruthlessness. The essence of pity is unselfishness and sacrifice and in the hygienist these are necessary qualities."

"The life of a medical man is one of curiosity and in some this may be extremely highly developed and the search for truth becomes a passion and a purpose. Research needs a natural urge and aptitude, a long apprenticeship in technique, untiring industry, the highest self-criticism and above all the passion for beauty."

"Another quality the public health worker needs is courage—courage born of belief and faith in one's work."

"Education, guidance and more co-operation between the public and the medical profession are some of the modern trends of public health. There is a growing feeling that in public health policy, too much compulsion is undesirable and should be kept rather for times of emergencies and extraordinary danger. Indifference, ignorance and conservatism and the idea that health is the affair of the sanitarian, are definite handicaps to the health workers."

"A free and honest discussion on the population problem on the following lines would help greatly :—

1. Are numbers alone the cause of general economical stress ?
2. How far the methods of population restriction alone be the cause of population adjustment ?
3. Should the State give facilities for instructing the public in methods of birth-control for :—
   (*a*) medical reasons ;
   (*b*) general economic reasons.
4. What would be the effects of (*b*) alone on the rural masses of India?

"The idea of population restriction seems to be based on the apprehension of the increase of the so-called lower classes or races and the desire for security is from the self-preserving instinct. We should remember our stability is but balance and conduct and lies in masterful administration of the unforeseen."

"I have indicated what I consider should be the attitude of the medical man and the public health worker towards the science and his work. A constant desire for truth, an appreciation of the beautiful and of the essential of the realities and unity of these two ; a spirit of sympathy and pity for the human race ; continuous assiduity in the alleviation and prevention of disease ; a belief in the possibility of upward progress of mankind through evolution controlled by intelligence, and in the application of the ideals of preventive and constructive medicine in the development of man's higher attributes, a spirit of conviction and courage in the face of difficulties."

C. V. N.

PSYCHOLOGY.

DR. GIRINDRASEKHAR BOSE, the pioneer of the psycho-analytical movement in India, has made a distinctive contribution to our understanding of the human mind, in the course of his Presidential Address to the Psychology Section of the Indian Science Congress, of 1933. Dr. Bose has given us a new theory of Mind which may be briefly referred to as the theory of the *Opposite Wish.*

As the theory has gradually evolved in his mind in the course of his work along Freudian lines, we may be permitted to briefly state the fundamentals of the Freudian system, to begin with. Prof. Sigm. Freud traces all mental derangement to repressed wishes chiefly of an infantile sexual character, which try to act in an autonomous way from the unconscious mind. Once they are brought up to consciousness they are supposed to yield to reason and persuasion, and lose their irrational and morbid character. These unconscious infantile sexual cravings tend tô express themselves in various ways, such as dreams, phantasies, errors and slips of the tongue and pen, accidents, outbursts of temper, humourous sallies, crimes, etc. The ego is supposed to exercise the censoring influence on all unconscious dynamic mental contents. Merely bringing back to consciousness of an unconscious wish does not affect a cure, the emotions attached to the unconscious desire should be *lived* over again. The above in brief is the orthodox Freudian position. Let us now set forth the departure from this proposed by Dr. Bose.

Dr. Bose observed, in the course of his extensive practice in Calcutta, certain phenomena which appear to have been overlooked by the Freudians in the Western countries. He noticed that the symptoms of mental derangement, do not disappear even when the patient has accepted the truth of the physician's psychoanalytic interpretation. On the other hand, he noticed a curious transformation in the symptoms, which leads one to suppose that every wish in the unconscious is accompanied by its opposite. The nature of the symptoms changed in such a manner as to indicate the operation of the Opposite of the original wish. As the analysis proceeded, the opposite wish comes into the conscious mind and the primary repressed material loses its significance. When in turn the Primary wish is brought to consciousness again, the Opposite wish would similarly lapse into the Unconscious. Dr. Bose found that this *See-saw mechanism* as he calls it, goes on with striking regularity, but with a gradually decreasing intensity of the Opposite tendency, and an increasing frequency of oscillation, till a time comes in the course of the treatment, when both the Primary and the Opposite wishes would simultaneously emerge into consciousness —and it was only then, that a real and complete cure is effected by the Psycho-analytic procedure; all other cures aim only at the symptoms and not at the causes underlying the derangement.

According to Dr. Bose's new theory of the Opposite wish there is no need to postulate the mysterious Censor, who is supposed to keep guard at the threshold of consciousness. The theory of the Opposite wish explains all the facts of repression, mental conflict, in a simpler manner than the doubtful structure built up by the Freudian school, which need to be propped at many points by special arguments. Identification, Projection and Reversal, which are usually supposed to be Primary activities of the ego, defying further analysis, can be understood in simpler terms, if we accept Dr. Bose's theory of the Opposite wish. His theory in short does away with the multiplicity of formulations invented *ad hoc* to explain away special difficulties.

We may congratulate Dr. Girindrasekhar Bose on the notable contribution he has made to our understanding of human nature.

M. V. G.

ZOOLOGY:

PROF. GOPALA AIYER, proficient as he is in this branch of biological study, and with his record of work round the British coast and in the Mediterranean Sea, is entitled to speak with authority on a matter, which has so far received only very scanty attention in India. Unfortunately, geographical and climatic conditions, the present financial position and probably also a certain apathy on the part of the Government and the people of India have together conspired against the fulfilment of the ardent wish of the naturalist in India, the exploration of the Indian marine resources.

Prof. Gopala Aiyer begins with a very illuminating account of the history of the growth of marine biological research in Europe. The pioneer work of the famous expeditions of the "Challenger", "Albatross", "Michael Sars", "Discovery" and others has added not a little to our knowledge of the conditions of deep sea. The first point of importance that has emerged out of the untiring work of this noble band of naturalists in charge of these expeditions is the striking uniformity of the laws that govern life in the sea. The relationship that exists between marine animals and their medium is much more simple than that between land animals and their medium. Indeed the uniformity of composition of the aquatic medium has brought about this uniformity of structure of the organisms that live in it. It is probably this simple relation between marine animals and the sea that has made experimental biology such a success. But the marine investigator is faced with other problems of really great importance and difficulty, inherent in the medium on account of its constant movement resulting in a far from satisfactory knowledge of the fauna and flora of the sea.

The problem of the food of the countless myriads of organisms found in the sea is the first that attracts our attention and for which an effective solution is offered by the plankton. Numerous workers have unanimously affirmed that plankton which consists mainly of Diatoms and Copepods offers the staple food of marine organisms. A seasonal variation in its occurrence is one of the main characters of plankton and various explanations are given for this. Probably like all natural laws this one also is based on a very fine adjustment of environmental conditions. But a far more striking feature of plankton is its abundance in colder seas and its relative rarity in tropical waters. Though several explanations are offered to account for this phenomenon, it is probably true that in case of waters with an abundance of nitrate food and other nutrient salts, plankton is also abundant. While, however, tropical plankton is rich in species, that of the arctic and antarctic waters is rich in individuals. This is probably due to the more sustaining nature of the colder waters due to a reduced rate of metabolism.

The relation between environmental conditions and life's processes is at once clear and

mysterious. It is a matter of common knowledge that increase in temperature means increased rate of metabolism, which, in itself, acts as a powerful inhibitor of growth in size. This is probably why larger animals abound in the colder seas. Indeed, various aspects of life-history, growth and development, reproduction of animals and their distribution, all show a very curious correlation with changes in temperature. Probably second only to temperature comes sunlight. The bearing of this factor on life in the sea is one of supreme importance and indeed is the factor that governs the vertical distribution of animals. However, the fact that plankton is to a great extent dependent on sunlight is admitted. And when we realize the intimate relations between plankton and the larger forms of life in the sea, the importance of sunlight as a governing factor of life becomes at once obvious. But there exists a whole host of animals far down in the dark leaden depths of the ocean where hardly any light penetrates, whose life is one great and continuous uniformity. How profoundly these animals differ from the surface forms in structure, in bionomics, in behaviour and in development is a matter of common knowledge. While salinity is a factor far less important than either temperature or sunlight on account of its comparative changelessness, it is near the coastal lines that any deviations may occur, due to the encroachment of fresh waters. And consequently it is these shore animals that have adapted themselves to a certain extent to the changing salinity of the medium. Further than this, salinity is incapable of acting as a guiding factor of life in the ocean.

The problem of the sea-shore is of such importance that literature on this aspect of marine biology is growing rapidly. The sea-shore combines such a variety of physical and biological factors and with such regularity that it has been rightly called the hot bed of evolution.

Prof. Aiyer makes no mention of the life at the sea bottom, the animals of the abyss, the enormous number of factors that governs the lives of these animals, their apparently changeless but extremely interesting environment, their form and size, their distinctions and peculiarities. But probably this is the most difficult aspect of the research of the sea, characterized by danger and fallacious argument.

Prof. Aiyer concludes his admirable summary of life in the sea with a very vigorous plea for an all-India marine biological station and suggests, very rightly, Pamban as an ideal place for such a station. The need for such a station is admitted but it is the great factor of co-operation that is required in India to-day to make this need an accomplished fact.

B. R. S.

Letters to the Editor.

Observations on *Tolyposporium penicillariæ* Bref. (The Bajri Smut Fungus).

A SMUT disease has long been known to occur on Bajri (*Pennisetum typhoideum* Rich.), one of the staple crops of Gujarat and, although in ordinary years it does not cause serious loss, in wet years the damage to the crop may be appreciable.

Beyond the identification of the causal fungus and the observation that the germination of the spore-balls is "scanty and difficult"[1] no work had been done on this disease until 1930 when one of the writers of this note (S.L.A.) reported the successful germination of the spore-balls readily taking place on several artificial media.[2] Since that time the disease has been further studied jointly by the writers at Ahmedabad and Baroda. The fungus has been studied in the field and in the laboratory and inoculation experiments have been carried out.

The main conclusions reached so far in this work are summarised below:—

(1) The fungus can be easily cultivated by sowing spore-balls on corn meal, Bajri meal and Jowar meal agar, and on boiled potato and boiled carrot. The sporidia multiply indefinitely by budding on these media. Very little mycelium is formed on any of the media tried and the growth consists almost entirely of sporidia.

Cultures of the fungus were also easily obtained by aseptically opening unripe, green-affected grains and suspending the whole mass of white mycelial ball found within on malt-agar slants.

(2) Infection takes place at the flowering stage of the host as in wheat, but no dormant mycelium in the infected grains is formed in the case of Bajri smut, the infection being followed in about two weeks from the date of inoculation by the formation of spore-balls.

(3) No other part of the host plant seems to be vulnerable to the attack of the fungus, though in one case the inoculation experiments carried out at Ahmedabad suggest the possibility of successful wound infection through pin pricks of the shoot. In any case, no part of the host plant, other than the grain, developes the spore-balls. Many grains in an affected ear escape infection. Even in the same spikelet one grain may be affected while the rest remain healthy.

(4) Microscopic study of the affected grains in various stages of development has shown that the fungus occupies the space between the pericarp and the aleurone layer and forms its spore-balls after gradually exhausting the starchy endosperm. In the beginning a peculiar white mycelium is found to exist in the affected grain. The nuclei in this mycelium are long, streak-like. The dark chlamydospore-balls are developed at the cost of this mycelium.

(5) Contrary to what has been previously believed[3], no resting period is necessary for the spore-balls to germinate at least on artificial media.

(6) Seed treatment with copper sulphate and sulphur is entirely unsuccessful in the case of this smut.

(7) None of the common varieties of Bajri is immune to this disease.

(8) The attack of the disease is more severe in wet seasons than in dry ones and more severe in those ears which come out during wet weather than in those which come out in dry weather. The later ears (formed when the weather is dry) even on plants which had earlier shown the disease have been found to have escaped the disease. This points to the possibility of dodging the disease by adjustment of the sowing date and by selection of late varieties.

The source of infection of the first grains in any season is still a mystery, for, although the spore-balls have been ascertained to retain their germinating capacity for at least two years, they have not been so far found to germinate except on artificial media. A close study of the behaviour of the spore-balls as they lie in the soil and also of weed grasses in Bajri fields as possible alternate hosts for the fungus may lead to the solution of this mystery.

Botanical Laboratory, S. L. AJREKAR.
Gujarat College,
Ahmedabad.

V. N. LIKHITE.
Research Laboratory,
Agricultural Experimental Station,
Baroda.

November 22, 1932.

[1] Butler, E. J., *Fungi and Disease in Plants*, p. 225.

[2] Ajrekar, S. L., *Proc. Ind. Sci. Congress, Bot. Sec.*, 1931.

[3] Butler, E. J., *Fungi and Disease in Plants*, p. 226.

Liverworts and Fern Sporophytes.

DURING the last week of August of this year, I collected some liverwort material in Landour, Mussourie, in the north-west Himalayas. On examination, after it was brought to Lucknow, some young fern sporophytes were found among the Liverworts. The sporophytes were still attached to the prothallus and on the underside of the young sporophyte leaf, sporangia were found as shown in the accompanying sketch (Fig. 1).

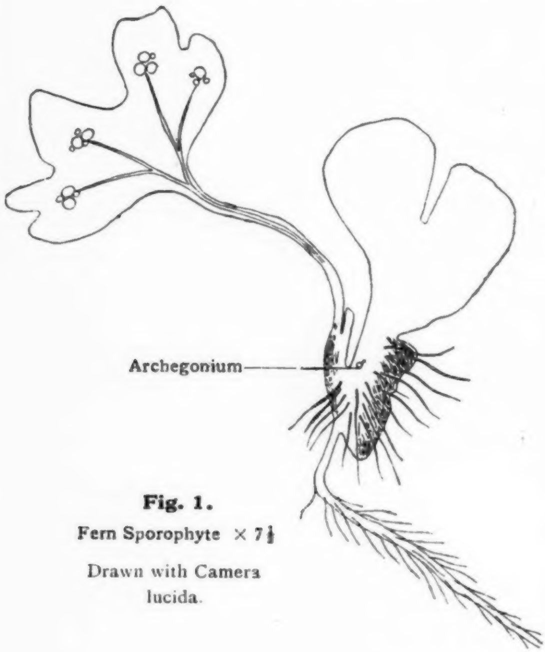


Fig. 1.
Fern Sporophyte × 7½
Drawn with Camera lucida.

Fig. 2. × 55
Sporangium
Drawn with Camera lucida

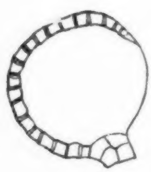


Fig. 3. × 55
Side View: Sporangium
Drawn with Camera lucida

Some of the sporangia were black, indicating maturity and the spores (Fig. 4) were sown in an attempt to germinate them, but they failed to do so.

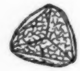


Fig. 4.
×110
Single Spore

The sori were without indusium and consisted of sporangia of different sizes, indicating their position in the Mixtæ or Gradatæ of Bower. It is also noted that the sporangia have a very short stalk and vertical annulus (Figs. 2 and 3).

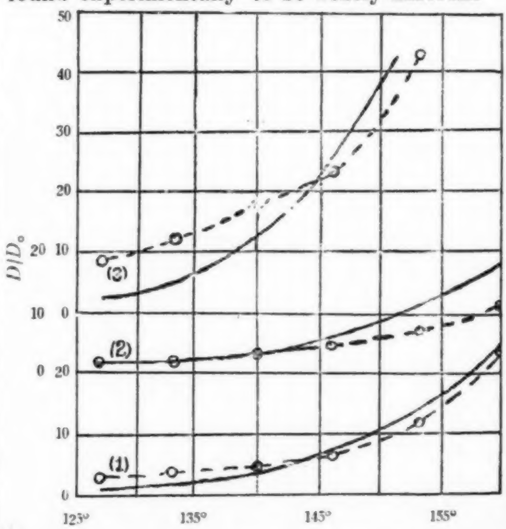
The prothallus appears to consist of two parts, a bulbous one which bears rhizoids and sex organs (one archegonium was found as shown in Fig. 1), and the usual heart-shaped leaf-like structure, which has a different cellular structure from that of the sporophyte leaf and no vascular tissue, which would indicate that it is part of a prothallus.

Since spore-formation is associated with the mature sporophyte plant, these specimens seem worthy of note.

R. H. OLDROYD.
Isabella Thoburn College,
Lucknow,
November 15, 1932.

The Wave Statistical Theory of the Anomalous Scattering of α-Particles.

THE recent experiments of Bieler, Chadwick and others have created a considerable interest in the subject of anomalous scattering of α-Particles. The intensity of scattering specially at large angles has been found experimentally to be widely different



Angle of Scattering in degrees.
(1) Carbon. (2) Boron. (3) Beryllium.

from that given by the inverse square law. Of late, A. C. Banerjee (*Phil. Mag.*, **9**, 273, 1930) has extended Wentzel's wave mechanical method by taking a polarisation force varying as $1/r^3$ and has obtained a formula which only partially agrees with Bieler's experimental values for Aluminium and Magnesium. This formula, it may also be remarked, fails to explain the very high values of scattering for the lighter elements, *e.g.*, Carbon, Boron and Beryllium as recently observed by Chadwick (*Proc. Royal Society*, **134**, 154–170, 1931). Very recently Taylor (*Proc. Royal Society*, **136**, 605, 1932) has also given a theory of scattering by Hydrogen and Helium. But as he himself admits, his method is not applicable to elements other than the above.

In a paper which is in progress I have derived on the basis of a polarisation force varying as $1/r^5$, the following formula:—

$$D/D_\circ = \left\{ 1 - \frac{\frac{4\pi^2 r_\circ^2}{\lambda^2}\,\mathrm{Sin}^2\theta/_2}{\mathrm{Cos}\left(\frac{4\pi r_\circ}{\lambda}\,\mathrm{Sin}\;\theta/_2\right)} \right\}^2$$

It is in good agreement even with the recent experiment of Chadwick as is evident from the figure where the curves obtained from the above formula are drawn continuous.

K. K MUKHERJEE.

Serampore College,
Serampore, Bengal, India,
November, 1932.

The Water Resistance of Shellac.

THE water resistance of a shellac varnish film is not good and detracts from its value for certain uses. The possibility of improving this property has been examined in this laboratory.

Amongst the works previously published on this subject that of Paisley (*J. Ind. Eng. Chem.*, **24**, 2, 163) is of importance. He describes the marked improvement in the water resistance of "bleached shellac" varnish films produced by inclusion of 10% tricresyl phosphate. Repetition of this work with pure "unbleached" shellac has shown, however, that the effect of tricresyl phosphate on this type of varnish is small. No improvement was found in the liability to flushing and the amount of water absorbed; although the cracking produced by rapidly drying the film was considerably less in the plasticised film.

Marked improvement in water resistance of baked shellac films has been observed and optimum conditions of time and temperature investigated.

The effect of such modification as addition of plasticiser and baking on other properties of shellac films has also been examined.

It is hoped that a paper describing this work will shortly be published.

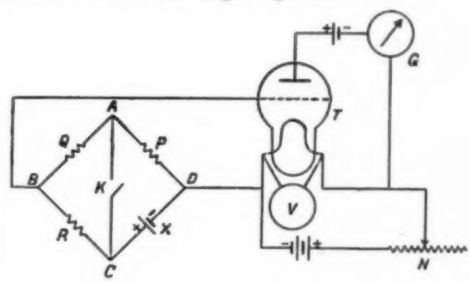
R. W. ALDIS.
M. RANGASWAMI.

Indian Lac Research Institute,
Namkum,
October 28th, 1932.

Application of the Thermionic Valve to the Measurement of Battery Resistance.

IN Mance's method for the measurement of battery resistance the current that passes through the galvanometer all the time produces a deflection right off the scale. Various suggestions, such as the use of a controlling magnet, an auxiliary current, a differential galvanometer, etc., have been made to get over the difficulty. In Lodge's modification of the method a condenser is used in series with a ballistic galvanometer. In the following notes is described an arrangement in which a thermionic valve is used to avoid the difficulty stated above.

The details of the arrangement are indicated in the following diagram:—



P, Q and R are the three arms of a Wheatstone's bridge, X is the cell of which the resistance is to be measured. K is a make-and-break key. T is a thermionic valve, the valve used being one of Marconi type D.E.3. V and N are voltmeter and rheostat to regulate the filament current. G is any ordinary galvanometer. There are two accumulators in the filament circuit and one in the galvanometer circuit.

When the circuit is completed (K remaining open) the initial current which passes

through the galvanometer is not, ordinarily, strong enough to deflect the spot of light off the scale; and even if it is found to be the case the spot can be easily brought back on the scale by increasing the resistance N of the filament circuit. The arrangement is found to be quite sensitive. On completing the circuit at K the spot moves from its position of steady deflection through an appreciable number of divisions of the scale even for a slight lack of balance of the bridge.

The resistances of a few cells were measured by (A) Mance's method as well as by (B) the modified arrangement detailed above. The results are given below. The tests were carried out using solutions of zinc sulphate and ammonium chloride of different strengths on different dates. It will be found that the results obtained by the two methods fairly agree.

RESULTS.

Resistance of one Daniell's Cell (in Ohms.)

Method A ..	0.78	1.12	1.30	1.43	1.44
Method B ..	0.80	1.13	1.30	1.43	1.50

Resistance of one Leclanche's Cell (in Ohms.)

Method A ..	0.70	1.00	1.90	3.20	3.20
Method B ..	0.70	1.00	1.90	3.15	3.20

R. C. SEN.

Physics Department,
G.B.B. College, Muzaffarpur,
May 10th, 1932.

Research Notes.

Halogen Compounds of the Rare Gases.

ONE of the most interesting communications that have appeared in the chemical publications of the last few months is that made by Antropoff, Weil and Frauenhoff (*Naturwissenschaften*, **20**, 688, 1932). Starting from the generally accepted assumption that the valency of an atom depends upon its tendency to have only eight electrons in the outermost "shell", these workers concluded that the rare gases need not necessarily have zero valency; they could as well be octavalent (helium divalent). It was thus expected that especially the heavier of the rare gases could form compounds above all with the halogens.

The experimental arrangement was roughly as follows:—A mercury pump is arranged to send crypton gas through a series of glass tubes through which electrical discharges of high intensity can be sent and also through some bulbs cooled by liquid air. The pressure of the crypton varied between 5 to 1 mm., and as its vapour pressure at the temperature of the liquid air is 17 mm. the crypton does not condense. In the discharge tube, the crypton was mixed with chlorine, which is again removed from the mixture by freezing, when it passes through the cooled bulbs. A MacLeod manometer was used for measuring pressures.

It was seen that as soon as the electric current was switched on, the gas-pressure was observed to sink to as much as half its value in 10 minutes. This diminution in pressure is also obtained with crypton and bromine, but not with argon and chlorine nor when the crypton-chlorine mixture is not subjected to the electric discharge. The only explanation which would explain this diminution of pressure is that a compound between the crypton and the halogen is formed and condensed by the liquid air. Moreover, a dark red substance was always observed in the freezing bulb whenever and only when a diminution of pressure took place and it was seen to be much more volatile than chlorine and possesses a band-spectrum. It can even be made to react with calcium, the reaction being violent, and the remaining gas shows then the pure spectrum of crypton.

Curiously enough, this crypton chloride seems to be quite a stable body, and the gas obtained from the above-mentioned red body, after standing for a number of days at room temperature, can again be condensed to the same red coloured substance. Even in contact with hot mercury, the rate of decomposition is very slow.

One can scarcely over-state the case if one says that Professor Antropoff and his colleagues in Bonn have made here an epoch-making discovery and if their observations are verified by other independent observers, they will constitute one of the most important supports for the Bohr-Rutherford atom.

The Inheritance by an Insect Vector of the Ability to Transmit a Plant Virus.

[Storey, H. H., *Proc. Roy. Soc.*, B, **112**, 46 (1932).]

THE possibility of having unequal ability to transmit a virus by the different races of a

species was suggested several years ago; but Dr. Storey working on the races of *Cicuduli-nambila* and the virus of streak disease of maize has experimentally demonstrated that it is actually so. He further states that the ability to transmit the virus is inherited as simple dominant Mendelian factor, linked with sex.

Experimental Distortion of Development in Amphibian Tadpoles. Pt. II.

[Sladden, D. E., *Proc. Roy. Soc.*, B, **113**, (1932).]

FROM observations made on a large series of experiments of various kinds involving the rearing of many thousands of frog tadpoles, the author concludes that apart from action of sugar or pH variation there is another factor which has a fundamental influence on the developing eggs of these animals. This unknown factor, according to the author, comes into play as a result of overcrowded conditions. Under these conditions the oxygen content of the water is reduced while the amount of CO_2 and nitrogenous products are automatically increased. The greatest number of abnormalities occur among those animals which are most weakened through lack of food and oxygen.

Carotinoid Colour Substances of Fishes.

LONNBERG (*Arkiv: for Zoologi*, **23A**, Hafte 4, 1932) has determined the nature of the colour substance of fishes by chemical tests, especially with the aid of antimony chloride and has come to the conclusion that the so-called lipochromes of fishes are really carotinoids. A large number and variety of fishes have been examined, and a comparative account of the respective spectra of the carotinoids reveals that the colour solution of the majority of them cannot be fractioned and must therefore be unitary. And in many cases the carotinoids belong to the xanthophyll group and this is of great interest as many of the marine invertebrates which serve them as food belong to the carotine group.

The Age of a Monazite Crystal.

[Fenner, C.N., *Amer. Jour. Sci.*, **136,** 1932.]

FENNER's contribution is of special interest in view of the growing possibilities of being able to determine geological ages by calculations based on the principles of atomic disintegration of radio-active elements. The uranium, thorium and lead contents of the monazite crystal have been determined and on the supposition that the lead has been derived from thorium by radio-active disintegration, an age of 277,900,000 years is calculated. Seeing that this result agrees very closely with the age of an uraninite from the same quarry determined several years ago as 282,900,000 years by W. F. Hillebrand, it will be obvious that the fundamental principle involved in this method of calculating the age of radio-active minerals is essentially sound and reliable.

Notes on some early Blastocysts of the South American Bat,—Molossus.

[G. S. Sansom, *P.Z.S.*, Part I, March 1932, pp. 113-118.]

THE early development of Molossus agrees fairly closely with that of the other Micro-Cheiroptera. The orientation of the blastocyst at right angles to the mesometrial axis is noteworthy; it occurs in all the six early stages, but is not preserved in the last, considerably later blastocyst, where the embryonal disc is directed more towards antimesometrial side. The primitive amniotic cavity arises as a cleft in the amnioectodermal mass and its formation is apparently initiated by the rearrangement of the cells. The roof of this cavity thins out and ultimately disappears with the result that a cavity is formed bounded on the one side by the shield ectoderm and on the other by the thin layer of covering trophoblast. The definite amniotic cavity is formed by the ingrowth of ectoderm from the margins of the ectodermal shield in contact with the covering trophoblast. The slight activity of the cytotrophoblast and the apparent absence of syncytiotrophoblast even in the latest stage described are noteworthy. The trophoblast in these early stages appears to be devoid of phagocytic or cystolytic properties.

The Genus Hyracotherium.

THE European and American genera of Eocene horses have been subjected to a revision in an interesting paper (*Phil. Trans.*, 1932, **B 221**, 481) by C. Forster Cooper. The prevailing practice is to give the American forms the name Eohippus and the European forms Hyracotherium, Propachy-

nolophus and Pachynolophus and there is a difference of opinion whether Hyracotherium differs from Eohippus or not. Cooper after examining the material contained in the British Museum, the Royal College of Surgeons, the American Museum, the casts of Pachynolophus and Propachynolophus from the University of Lyons and the Cambridge specimens in the collection of the Sedgewick Museum, has come to the conclusion that all the specimens of Eocene horses discovered in Britain constitute a single genus Hyracotherium comprising three species, H. cuniculus, H. leporinum and H. vulpiceps. The forms Hyracotherium and Eohippus present more points of similarity than difference and the distinction hitherto drawn between them is untenable. Judged from the dental characteristics, Hyracotherium cannot be considered as more primitive than Eohippus, the species of the former belong to the same stage of evolution as those of the latter. No distinction can be drawn between the European form Propachynolophus and the British genus Hyracotherium and some forms of Pachynolophus are hardly distinguishable from the latter.

Thalamic Connections in the Rat.

THE experimental study of thalamic connections in the rat by W. E. Le Gros Clark (*Phil. Trans.*, 1932, **B 222**, 483) has given some extremely interesting results having a bearing on the interpretation and significance of the different nuclear centres in the optic thalamus. The relations of the nuclear centres to the cerebral cortex and with other parts of the brain studied by Marchi technique offer interesting points of phylogenetic importance. It is found that the more dorsal and lateral parts of the ventral nucleus have fibrous relations with the dorsal area of the parietal region of the general sensory cortex and the ventral aspect of the nucleus ventralis being connected with the ventral and medial parts of the same sensory and insular areas. Thus the fibres take a definite route to the cortex. No thalamo-cortical fibres from the medial ventral nucleus could be traced in the rat but the degenerate fibres traceable from the site of lesion suggest that they are thalamo-striate in nature. The nucleus medialis ventralis is regarded as homologous with the nucleus rotundus of reptilian diencephalon because of the topographical relations and the connections of the nucleus in both cases with corpus striatum. In the evolution of mammals it is significant that the medioventral nucleus so well defined in the primitive forms gradually becomes indistinct till it is finally lost in the primates. The studies of Clark lend evidence in support of Edinger's contention that there is a thalamo-mamillary component of the bundle of Vicq De-Azyr besides the transverse connections of the two anterodorsal nuclei of the anterior group, across commissura-inter-antero dorsalis. Of the three elements composing the anterior group of nuclei, the antero-ventral one is connected with the whole area singularis of the cortex by corticipetal fibres, while the antero-medial nucleus provides no evidence of cortical connections but has connections with the antero-ventral nucleus of its own group, the nucleus medialis ventralis and also with the nuclei of periventricular system. No evidence could be obtained for establishing cortical connections with antero-dorsal nucleus. Of the three components forming the anterior group of nuclei the antero-medial one may be regarded as representative of the palæo-thalamus and evidence has been adduced to establish its derivation phylogenetically from the nucleus dorso-medialis of the reptilian thalamus, a nucleus which is not related to the somatic areas of the lateral part of the fore-brain. Regarding the lateral nucleus which comprises pars principalis and pars posterior, the conclusion is reached that the former is related by reciprocal fibre connections to the most dorsal limit of the parietal area on the lateral surface of neo-pallium close to the median line,—this conclusion fits in with the conception that the great expansion of the main part of the lateral nucleus in higher mammals is associated directly with the progressive elaboration of the parietal association areas in these forms. There is no evidence to establish the corticifugal connection of the pars posterior. The dorso-medial nucleus which is equivalent of the medial nucleus of the human brain is regarded by certain authors as a palæo-thalamic centre (which is really the antero-medial nucleus of the anterior group as has been shown by Clark). In fact the nucleus dorso-medialis is one of the recently developed thalamic elements and is not homologous with the nucleus dorso-medialis of reptilian diencephalon. For this reason, it is desirable not to include it in the medial nuclear group. The studies of Clark have still left in

doubt whether the nucleus pretectalis is part of the thalamus, occupying as it does a position at the junction of the mid-brain and the diencephalon. There is evidence, however, that it has fibre connections with the posterior part of the parietal area of the cortex but not a corticipetal character. The system of the nuclei of the midline is formed by the descending fibres of the ganglia habenula and of the dorso-medial nucleus. From the evidence adduced by the researches of Clark, it appears that in the rat cortico-thalamic fibres terminate in all the principal nuclei of the thalamus with the exception of the nucleus antero-medialis, nucleus medialis-ventralis and the nuclei of the midline. In the higher mammals such connections are apparently very insignificant. The experiments on the rat show that corticotectal fibres arise from the occipital lobe of the cerebrum which is in accordance with the observations of previous authors. There is also evidence that in the rat all the principal nuclei of the thalamus proper send off projection fibres to the neopallium with the exception of antero-medial nucleus, nucleus medialis ventralis and nuclei of the midline. These are therefore the only thalamic elements which can be considered as homologous with the palæothalamus of great phylogenetic age.

An Analysis of Some Necrotic Virus Diseases of the Potato.

AN analysis of some necrotic virus diseases of the Potato forms the title of a valuable article by R. N. Salaman and F. C. Bawdan (*Proc. Roy. Soc.*, **B III**, 769, 1932) in which after giving full details of the previous works of the subject, the authors describe how our views on the virus diseases of plants have passed through the phase when protein reactions are mistaken for specific disease and given special names, *e.g.*, the leaf-drop streak which is known to be induced by one single virus and that virus is Kenneth Smith's Y. It is further known that Quanjer's top-necrosis is caused by different agents altogether. In limited number of varieties this disease can be produced by Kenneth Smith's X virus acting alone. The other varietal reactions are designated as Top-Necroses A, B & C. Top Necrosis A is shown to be caused by a complex of both X and Y possibly associated with virus Z. Top Necrosis B is likewise due to a complex containing both Z and Y. Top Necrosis C is caused by both X and Y. Top Necroses X and C complexes are transferable to other Potato varieties by needle inoculation. Top Necroses A and B are uninoculable except that A can be conveyed to varieties like Arran Crest and Epicure, by needles. Top Necrosis A is found among the widest grown varieties such as the Arran Banner, Majestic and Up-To-Date, a fact that leads to this consideration of practical and economic importance. Looked at from the pathologist's point of view, these carriers of virus are vast reservoirs of the most destructive of all the virus entities we know, dangers to other varieties and even a danger to themselves—for a carrier Up-to-Date can go down to a further infection of the very virus which it itself is carrying. The authors suggest a way out of the dilemma either by aiming at growing only virus-free stocks—a possible though difficult and costly task—or using only such varieties as are successful carriers of the more serious virus diseases.

A Scheme for Advancing Scientific Research in India.

By Hem Singh Pruthi, D.Sc.

IN a recent issue of the *Current Science*[1] Prof. Gideon has put forward an elaborate scheme for the organization of research work in India. If I understand him right, the most important point he urges is that research in applied sciences like Agriculture, Medicine, etc., should not be restricted to a few central research institutions, but that some of the activities of such institutions should be retrenched and the teachers in the numerous mofussil colleges in the different provinces of India should be invited to work on research problems which have *direct* economic value from the Agricultural, Medical and Veterinary points of view. Only big university centres, according to him, should carry on research of purely academic nature. I request the hospitality of the columns of the *Current Science* for making some remarks on Prof. Gideon's scheme, especially in reference to research in entomology, admittedly the largest and most important section of economic zoology.

Presuming that there is enough justification for Prof. Gideon's statement that "the majority of mofussil colleges teaching science are free centres for research, having trained men with leisure for such work," it is very doubtful if they have well-equipped laboratories and libraries for doing research of direct economic value. A man working on the control of insect pests has often to consult literature not only on entomology but on several other sciences like Physiology, Biochemistry, etc. Few research workers will deny that small annual grants for the purchase of literature are in any way adequate and that frequent getting of books by post from a far off library hardly conduces to well-sustained and concentrated work. Nor does a short visit to a big library in the beginning or at the end of research work meet the needs, as literature has to be consulted simultaneously with the progress of work. Regarding the equipment of laboratories, the mofussil colleges will each at a time be able to undertake the study of one or two pests and the necessary apparatus, etc., required by several of them will often be similar. It will be readily understood that this multiplication of the same kind of apparatus in a province and the consequent considerable unnecessary expenses can be easily avoided if the study of all the pests is restricted to a few well-equipped central institutes in the province.

Moreover, the study of an insect pest is not purely an entomological problem, in as much as when devising means of control careful account has to be taken of the general agricultural practices prevalent in the area. An Economic Entomologist, therefore, has frequently to consult and remain in close touch with his colleagues in the sections of pure Agriculture, and other Agricultural Sciences.

The mofussil colleges, however, can do very important research work of purely academic nature and at the same time of great indirect economic value. They can study the anatomy, life-history, habits and ecology of insects, especially of the species which are harmful or beneficial to man at the present time or are likely to be so in future. They can easily ascertain the names of such species from the Economic Entomologist of their Province. First class research can be done on this aspect of Entomology. This kind of work can be done even at a comparatively isolated place without requiring much literature or expensive apparatus. I think that it is for this kind of research that the Imperial Council of Agricultural Research gives grants to teachers in science colleges. It is the most essential work preliminary to the solution of the problems of insect control which, as above explained, had much better be worked at a central institute or college. Needless to add that all the important universities in India or even in England recognize this kind of research work as quite suitable for theses for their research degrees.

Though the remarks made above have special reference to Agricultural Entomology they apply with equal force to medical and veterinary divisions of this science.

[1] *Current Science*, **1**, 133, 1932.

Science News.

THE Presidential Address by Mr. K. Dutt recently (July 1932) delivered before the Geological, Mining and Metallurgical Society of India, Calcutta, deals with the very important question of fuel economy and problem of second class coal. He has discussed at some length how certain types of coal are simply run down in the coal market by being labelled 'second class' on meaningless considerations—attributing inefficiencies in the boiler solely to the alleged 'poor quality' of the coal. He concludes by saying "There need not be any *pariah* among Indian coal fuels. By scientific methods they can be all reclaimed; by mechanical equipment, it is possible to make them yield the same or almost the same quantity of steam that could be possibly obtained from the burning of the so-called selected grade of coal."

* * *

A course of training in Marine Biology was given to teachers from different parts of the Bombay Presidency at the Royal Institute of Science, Bombay. The training consisted of lectures in Zoology and practical work including collection and handling of animals from sea shore, plankton by townet and animals from deep sea by dredging and trawling. The course has proved highly popular and it is hoped that it would be possible to extend the facilities to teachers and post-graduate students from other parts of India as well.

* * *

The Convocation Address of the Hindu University of Benares was given by Pandit Madan Mohan Malaviya who spoke in Hindi, exhorting the graduates to lead a simple life distinguished by the rare purity which belongs to the Age of Rishis but virile with the zeal and the thoughts of modern age of scientific discoveries. The Address is a packed essence of patriotic fervour worthy of a great man and the great place where he spoke.

* * *

Sir Frank Noyce addressing the Muslim graduates of Aligarh University dwelt at length on the nature of the University education which should be imparted to the 'ordinary man'. To him the education that really matters in life is what remains after he had forgotten most of what he had learnt in the University. Sir Frank Noyce has given an admirable summary of knowledge in contradistinction with Education and the ideals and the functions of the University.

* * *

In the course of a paper read before the Geological, Mining and Metallurgical Society of India, Mr. D. N. Wadia observed that a very complete tertiary sequence from the Eocene to Pleistocene occurs in the Potwar geosynclinal basin of north-west Punjab, lying between the Hazara Himalaya and Salt Range mountains, consisting of marine, lagoon and fresh-water deposits, 25,000 feet thick. This basin structure persists south-eastwards and expands into the much wider Indo-Gangetic synclinorium lying between the Himalaya and Deccan. The latter is filled with the same system of deposits as the Potwar, as seen in the 30-40 miles wide strip of Tertiaries exposed along the Himalayan foot. Much the largest part of this trough, however, is deeply buried underneath sub-Recent Gangetic alluvium, due to its persistent subsidence during Pleistocene times while Potwar was being elevated to a plateau. It was this differential earth-movement which separated the Indus drainage from the Ganges and reversed the direction of flow of the latter from north-west to south-east. Palæontological evidence shows that these changes were subsequent to the advent of Man.

* * *

The eighth annual session of the Indian Philosophical Congress was opened by H. H. The Maharaja of Mysore, who is known alike for piety, public zeal and profound learning. Mysore is almost the birth-place of the three great systems of Hindu philosophy and its archives are filled with some of the rarest manuscripts providing abundant facilities for research. His Highness' address after reviewing the modern developments in the physical and the biological sciences, points to the possibility of philosophy synthesising them into new concepts of human values thus marking a new era of progress in religion and our fundamental ideas of Godhead. The greatly troubled world perhaps may draw some solace from the renaissance which a fusion of philosophy and science might usher into our life enriching the mind with new forces for its exaltation.

* * *

The Presidential Address of Sir S. Radhakrishnan was taken up with an elaborate exposition of Sri Shankara's doctrine of reality. The admirably analytical method of expounding this controversial theme which, while it satisfies those who have had the benefit of training in methods of comparative study, may not appeal to the orthodox exponents of the Advaita system. We must restrain our temptation to enter into the discussion of a subject which can be easily converted into polemics but the theories of science perhaps will give the most convincing reply. Referring to the troubles of modern times, Sir Radhakrishnan holds that the present distractions and the tragedy of the age are due to a sense of narrow specialization and excessive intellectuality; for progress has not brought contentment but has produced a void in life. "If they wanted to develop a true spirit, a new era in philosophy, in literature, in art and in morality, they should have an adequate realization of the powers of man. A play of life, satisfaction of mind, a feeling of peace,—it was these they wanted and these would have to be adequately developed to get life eternal."

* * *

Dr. Himadri Kumar Mookerjee of Calcutta writes to us that in the course of his investigation on the Indian Urodele *Tylototriton verrucosus*, he has discovered the remains of two genera of molluscs, *Pisidium* and *Indoplanorbis*. According to him, this is the first instance of molluscs being recorded as forming the food of Urodela whose staple food is generally worms and small crustacea. Land and fresh water molluscs have been known to be taken as food by Anura, some of which like *Rana tigrina*, are even cannibalistic in their feeding habits and slightest movement on the part of smaller animals is enough to excite the attention of Anura and Urodela which proceed to grab them. A piece of charcoal tied to a

string and dangled before the toad *Bufo melanostictus*, is greedily snatched at, but thrown out the moment the mistake is discovered. It is well known that movement on the part of animals provokes the curiosity of their enemies with fatal consequences.

* * *

Under the auspices of the Asiatic Society of Bengal a symposium on the Early History of Northern Bengal was held on Monday, the 2nd January 1933. The following papers were read and discussed :—

"Note on the Early History of Northern Bengal." By H. E. Stapleton.

"Note on a Mauryan Inscription from Mahasthan." By D. R. Bhandarkar.

"Note on Three Kushan Coins from North Bengal." By N. G. Majumdar.

* * *

The Progress of Agricultural Co-operation in Mysore was the subject of a recent address before the Mysore University by Mr. S. Venkatakrishnayya. After drawing attention to the heavy indebtedness of the peasantry, the lecturer cited evidence to show that in co-operation lies the hope of salvation to rural India. The public have not, however, awakened to the reality of the situation and the progress of co-operation is very slow: thus, although Mysore stands fourth in the country with regard to the organization of co-operative institutions, yet hardly 6 per cent of the agricultural population of the State have taken any interest in the movement. The lecturer then cited instances to show how the Irish Free State, New Zealand and other progressive countries have organized their agriculture and trade on co-operative basis and indicated how similar methods can be introduced into Mysore. He laid particular emphasis on the need for (*a*) further legislation against usury, (*b*) creation of land-mortgage banks with facilities for short-term loans, (*c*) co-operative estate management and sale of produce, and (*d*) organization of rural education, village improvement and cottage industries.

* * *

In the course of an extension lecture delivered at the Lucknow University on 30th November 1932, Mr. C. Maya Das, dealing with "Unemployment and Universities", laid emphasis on the need for educated men and women applying their hands and brains to agriculture and related industries. He adduced evidence to show that there is ample scope for expansion in cattle-breeding and dairying, poultry keeping, sericulture, fishery, lac cultivation, bee-keeping and orcharding. There is also ready money in rice-hulling, oil-crushing, pickling and preserving, while considerable savings can be effected by silaging surplus fodder and converting domestic and farm wastes into manures. The lecturer concluded with exhorting his hearers to organize their efforts, to initiate co-operative ventures, to always aim at superior quality and to strive for rural uplift including hygiene, education and cottage industries.

Reviews.

INDIAN INDIGENOUS DRUGS. By Col. R. N. Chopra. First edition, pages xxii+655. (Calcutta: The Art Press, 1932.) Price Rs. 15.

Col. Chopra's latest book "The Indian Indigenous Drugs" is one of the most readable and useful publications which the reviewer has come across. The book owes its inception to an invitation by the Patna University to the author to give lectures as Sukhraj Ray Reader in Natural Science in 1929-30 on the medical and economic aspects of Indian medicinal plants. Later, as Chairman of the Drugs Enquiry Committee appointed by the Government of India in 1930–31, he came in intimate contact with the professions of medicine and pharmacy during his all-India tour and gathered together a large mass of useful information on the subject. Since the creation of the Calcutta School of Tropical Medicine in 1921, Col. Chopra has been in charge of the teaching and research work in Pharmacology, and has been engaged in the investigation of indigenous drugs. During these investigations he had the collaboration of the Department of Chemistry at the School in the two-fold preliminary work involved, namely, (1) the working out of the chemical composition of the drugs, and (2) isolation of their active principles. As physician to the Carmichael Hospital for Tropical Diseases, attached to the School, he has had ample facilities to carry out clinical trials with these drugs or their active principles. The book is divided into four parts. The first part deals with the necessity of research in the vast field of indigenous drugs. The term 'indigenous drugs' is used in a very broad sense and has been taken to include not merely those drugs which were originally the natives of India but also the exotics which had become domiciled. The author gives a historical survey of the different attempts at research on indigenous drugs during the last 100 years or so and points out the reasons for their failure to get any definite results. He then discusses the three main lines along which work was undertaken by the combined efforts of the Departments of Chemistry and Pharmacology of the Calcutta School of Tropical Medicine, aided by clinical trials at the Carmichael Hospital for Tropical Diseases. The aim of this work was both scientific and economic and may be summarised as follows:—

(1) To make India self-supporting by enabling her to utilize the drugs produced in the country and by manufacturing them in a form suitable for administration.

(2) To discover remedies from the claims of Ayurvedic, Tibbi and other indigenous sources suitable to be employed by the exponents of Western medicine.

(3) To discover the means of effecting economy so that these remedies might fall within the means of the great masses in India whose economic condition is very low. The desirability of using crude drugs, which are cheap, in place of the refined and finished preparations, is also discussed in this connection. The author makes out a special case for the cultivation of important medicinal plants in this country in view of the fact that India possesses a most wonderful variability so far as temperature and general climatic conditions are concerned. He very pertinently quotes Prof. Greenish of the London School of Pharmacy: "India, owing to the remarkable variations she possesses of climate, altitude and soil, is in a position to produce successfully every variety of medicinal herb required by Europe." It is, therefore, earnestly hoped that the subject will attract the attention of the Imperial Council of Agricultural Research and the Departments of Agriculture and Industries of the different Provincial Governments so that they may assist in prosecuting fundamental research on the subject which may stimulate the agriculturists to grow medicinal plants and the pharmaceutical chemist to manufacture drugs from them. The economic importance of this policy can only be fully appreciated by studying the position of the drug trade in India. The value of imports is estimated at about two crores of rupees per annum and that of exports at about forty lakhs. This adverse trade balance can be explained by the fact that drugs in crude form are exported from India to foreign countries at a nominal price, where they are utilized in various medical and allied industries and a portion of them is returned to India in the form of expensive preparations. A unique opportunity thus exists for the pharmaceutical chemist in this country, which if fully taken advantage of, will go a long way in removing unemployment among the educated classes. It will also bring into existence other allied chemical industries.

The second part of the book deals with pharmacopœial and allied drugs growing in India. The author has tried, in this section, to bring forward to the readers the enormous potential drug resources of India and the various ways and means by which these resources may be harnessed to the economic benefit of the country. A large number of these drugs grow wild and in great abundance in many parts of India but for want of definite knowledge about their constituents and active principles, these cannot be taken into use by the medical profession. The author has analysed a large number of these drugs himself and has shown that in many cases the Indian varieties are richer in their alkaloidal contents than those imported and can be safely used as a substitute for the more expensive foreign remedies. The readers will get very useful information and valuable suggestions regarding drug growing and drug manufacturing, not easily available elsewhere. The third part deals with the drugs used in the indigenous medicine. In this part a section is devoted to drugs of mineral and animal origin, and deals with makaradhwaja, musk, silajit and snake venoms. The chief object in both these parts of the book is to give a brief botanical description of the plants from which the drug is derived. This is followed by a short account of the chemical composition, the pharmacological action and the therapeutic uses of the drug. This is based mainly on the work done by Col. Chopra and his colleagues in the Departments of Pharmacology and Chemistry but a résume of practically all recent investigations on these drugs is also given. References for the convenience of the reader for getting further information from original sources are also inserted under each drug.

Part IV of the book deals with Indian *Materia Medica*. It is divided into three sections. Section 1 is a glossary of over 2,000 Indian medicinal plants. It gives the vernacular names, uses, chemical composition and references to any work published regarding them. This seems to be the most complete list of Indian medicinal plants published so far and has clearly cost a great deal of labour to the author. Sections 2 and 3 of this part deal with the inorganic and animal products used in the indigenous medicine.

Besides a comprehensive table of contents and a general index, the book contains an index of vernacular names of indigenous drugs, which is invaluable for purposes of reference.

From what has been said it is clear that this is a very useful book. It has both a scientific and economic interest. It should prove equally useful to the economic botanist and the organic chemist wishing to undertake work on important plant products and the medical man. Its economic interest lies in its usefulness as a guide to the agriculturist in showing him what types of medicinal plants should be grown and to the pharmaceutical chemist in indicating to him the possibility of manufacture of drugs derived from them. The book is well printed and is remarkably free from typographical errors. It is moderately priced.

B. K. S.

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The Vitamins. By Sherman and Smith. ("An American Chemical Society Monograph" issued by the Chemical Catalogue Company, Inc.")

Our knowledge of the vitamins is increasing in such a bewildering manner, that a review of the subject like that which is presented in Sherman and Smith's monograph is eminently welcome. The book gives a well-balanced survey of the different facets of this rapidly developing section of biochemistry. The bibliography, which covers nearly one-third of the entire book, will be very useful to research workers and indicates the colossal amount of labour, that is being devoted to the elucidation of the chemical nature and the physiological function of these dietary factors.

Beginning with an exposition of the origin and development of the vitamin theory, the chapters deal severally and successively with vitamins B_1, B_2, C, A, D and E. The almost romantic stories of the discovery of the precursors of vitamins A and D are related in a lucid manner. The chapters on the B-vitamins give an up-to-date and detailed summary of the present position of the subject. Reference is also made to the recognition of the newer factors, necessary for the nutrition of the rat and the pigeon.

Monographs on vitamins, however, tend to be a little out-of-date almost as soon as they are published. Thus since the publication of this volume, our knowledge of vitamin D has progressed considerably. Vitamin C has been identified apparently beyond doubt as hexuronic acid and in the reviewer's laboratory the production of a vitamin *in vitro* from a known substance has been attempted apparently with success. Nevertheless, monographs of the nature of Sherman and Smith's volume are very desirable, because they serve to coordinate the scattered data, which are accumulating apace. It is believed the book will be found useful by all those, who consult it.

B. C. G.

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The Mechanics of Deformable Bodies, being Vol. II of "Introduction to Theoretical Physics" by Prof. Max Planck. Translated into English by Prof. Henry L. Brose. (Macmillan & Co., Ltd., London, 1932.) Price 10*s.* 6*d.* net.

In these days of rapid advancement in Theoretical Physics it has become increasingly necessary that the serious student of Physics should have in his hands a work which presents the fundamentals of the subject in a consecutive manner and treats it with necessary mathematical rigour. One can unhesitatingly say that among such works Prof. Max Planck's "Introduction to Theoretical Physics" occupies the front rank. "The Mechanics of Deformable Bodies" forms the second volume of this work. The treatment is characterized by the clarity and conciseness which one expects from the eminent Mathematical Physicist. In introducing the subject the author, while drawing attention to the necessity of making simplifying assumptions in dealing with particular groups of problems, makes the pregnant remark that 'Nature does not allow herself to be exhaustively expressed in human thought', the truth of which recent advances in Theoretical and Experimental Physics have made the modern student realize more than ever.

The work is presented in three parts. In Part I the general laws of motion of a continuously extended body are dealt with under the two heads, laws of kinematics and dynamical laws, forming the ground-work for the superstructure built in Parts II and III. In Part II infinitely small deformations receive treatment under the headings: Rigid Bodies, States of Equilibrium of Rigid Bodies, Vibrations of Rigid Bodies and Vibrations in Liquids and Gases. Part III comprises General Remarks, Irrotational Motion, Vortex Motion and Friction. As one reads through the book one finds that the subject develops in a natural way with the fundamental problems coming under each head treated with a clearness and thoroughness hardly to be excelled. While everything is uniformly well done, no portion of the work calls for particular remark; we are,

however, tempted to draw particular attention to the Physical and Physiological aspects of musical intervals, musical scales and the ear as a Fourier analyser, models of clear and concise exposition. While speaking of the ear, the author says "An idea of this power of the organ of hearing, which borders on the miraculous, may be gathered if we reflect that the trained ear of a conductor is able to distinguish in the mass of sound produced by a combined choir and orchestra not only the tones and qualities of the individual instruments, but also the individual letters of the words that are sung. In this respect the ear is infinitely superior to the idea (*sic.* eye). For a colour, white, green or blue, is always experienced as something uniform and we are unable to specify directly whether and how this colour is composed physically of other colours."

The translation is well done. We heartily commend the volume to every earnest student of Physics.

B. V.

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Fertilizers and Food Production. By Sir Frederick Keeble. Pp. ix+196. (Oxford: The University Press, 1932.) Price 5s. net.

A charming volume dealing with the possibilities of intensifying crop-production by judicious application of fertilizers.

After surveying the causes which led to the present depressed condition of agriculture in Great Britain, the author proceeds to discuss the means of increasing home-grown food for the future. Experiments carried out in different parts of the country and particularly those at the Jealott's Hill Farm have shown in a convincing way that increased yields varying from 15–30 per cent. can be obtained by judicious and timely application of fertilizers. Great Britain is essentially a grassland country and the soil and climatic conditions are such that in most parts of the island far bigger returns can be obtained by intensive grassland farming than by arable farming. Experiments on grazing in intensively managed holdings have shown that a larger number of cattle and sheep can be maintained per unit area together with a considerable saving in the cost of concentrates than in the past. Furthermore, grass can be preserved for winter use by silaging or by special processes of quick drying which yield products that are superior to the present type of stored hay. The efficacy of strip grazing, rotation of crops applicable to grassland and the economics of fertilizing and the returns therefrom are discussed and evidence adduced to show that the farmer always stands to gain by judicious use of fertilizers. The book concludes with schemes for scientific use of fertilizers for different crops and an appendix of recent data supporting the various statements made in the text.

The book is unfortunately one-sided and deals only with the application of mineral fertilizers in British farming. No mention is made of possible extensions of such observations to agriculture in other parts of the world: nor is full justice meted out to organic manures, which in spite of their bulkiness and somewhat tardy availability are more consistent in their action than any combination of artificials that man has so far devised.

The book is written in delightful style and well illustrated with tables and charts. The printing is in excellent type and on good paper and Messrs. Oxford University Press deserve to be congratulated on their performance.

V. S.

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